THE

# ELECTRICAL REVIEW.

VOL. XLVII. SEPTEMBER 21, 1900. No. 1,191.

## CONTENTS:

| | PAGE |
|---|---|
| The British Association at Bradford ... ... ... ... | 445 |
| Overhead Construction, with Special Reference to Guard Wire (*illustrated*) ... ... ... ... ... ... ... | 448 |
| Molecular Changes Produced in Matter by Electric Waves (*illustrated*) ... ... ... ... ... ... ... | 449 |
| The Disposal of Towns' Refuse ... ... ... ... ... | 451 |
| Current Specifications.—XXIX. ... ... ... ... ... | 452 |
| Malleable Iron for Tramcar Details ... ... ... ... | 453 |
| Economy of Superheated Steam in the Turbine ... ... | 454 |
| The Ethics of Insulating Materials ... ... ... ... | 454 |
| A Criticism of the British Association ... ... ... ... | 456 |
| Cable Specifications ... ... ... ... ... ... | 456 |
| Correspondence:— | |
| The Doom of the Contractor ... ... ... ... | 457 |
| Guard Wires ... ... ... ... ... ... ... | 457 |
| Business Notes ... ... ... ... ... ... ... | 458 |
| The New Electricity Works of the Glasgow Corporation (*illustrated*) ... ... ... ... ... ... ... | 465 |
| Supply Station Accounts ... ... ... ... ... ... | 475 |
| City Notes ... ... ... ... ... ... ... ... | 476 |
| Traffic Receipts ... ... ... ... ... ... ... | 476 |
| Stocks and Shares ... ... ... ... ... ... ... | 476 |
| Share List of Electrical Companies ... ... ... ... | 477 |
| Market Quotations ... ... ... ... ... ... ... | 478 |
| British Association for the Advancement of Science:— | |
| List of Electrical Papers Read ... ... ... ... | 479 |
| The Automobile for Electric Street Traction (*illustrated*) | 479 |
| The Manchester and Liverpool Express Railway ... | 482 |
| Manchester and Liverpool Railways: Brakes and Signals | 482 |
| On the Apparent Emission of Cathode Rays from an Electrode at Zero Potential ... ... ... ... ... | 483 |
| Wireless Telephony (*illustrated*) ... ... ... ... | 484 |
| Cooling Plant at Oldham (*illustrated*) ... ... ... ... | 486 |
| Electricity Supply Mains ... ... ... ... ... ... | 486 |
| New Patents ... ... ... ... ... ... | 487 |
| Abstracts of Published Specifications ... ... ... ... | 487 |

THE

UNIVERSAL ELECTRICAL DIRECTORY

1900

Edition.

H. ALABASTER, GATEHOUSE & CO.,

*4, Ludgate Hill, London, E.C.*

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

*The Oldest Weekly Electrical Paper. Established* 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

*OFFICE:—4, LUDGATE HILL, LONDON, E.C.*

Telegraphic Address: "AGEEKAY, LONDON." Code, A B C.

Telephone No. 933 Holborn.

*ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.*

ADVERTISEMENT RATES ON APPLICATION.

**The "Electrical Review" is the recognised medium of the Electrical Trades.**

*SUBSCRIPTION RATES.*—In Great Britain, Post Free per Year, 19s. 6d. To all other countries, per Year, £1 10s.

*BINDING.*—Subscribers' numbers bound, including case, for 4s. each volume.

*CASES.*—Cloth Cases for Binding can be had, price 2s. 6d. each.

*READING CASES*, to hold from One to Twenty-six Numbers until the volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d.

*FOREIGN AGENTS.*—New York: D. VAN NOSTRAND, 23, Murray Street. Paris: VEUVE J. BOYVEAU, 22, Rue de la Banque. Berlin: ASHER & Co., 13, Unter den Linden

Cheques and Postal Orders (on Chief Office, London), to be made payable to Mr. H. ALABASTER, 4, Ludgate Hill, E.C.

## THE BRITISH ASSOCIATION AT BRADFORD.

BRADFORD is not likely to regret the second visit of the British Association for the Advancement of Science to that city, nor will the Association look back upon the conference with feelings of anything but satisfaction. Situated in the heart of a district which is world-renowned for its industries, the Bradford meeting was destined from the first to be far more successful than was last year's gathering at Dover. Perhaps it is not right to say that there was a great rush of scientists to Bradford, for the number of tickets sold was below 1,900, but from the record which we are publishing in the ELECTRICAL REVIEW of the papers and discussions pertaining to electrical science and engineering, it will be seen that the meeting was fairly successful from the electrical point of view.

The presidential address of Sir William Turner was not anticipated to be of any particular interest to the electrical engineer, admirable as it appeared to the biologist and anatomical specialist; nor was that of Sir Alexander Binnie, delivered to Section G, of immediate practical import, although it was a work which must have been the outcome of many years' careful classical research in tracing the historical development which has taken place in the domain of science and engineering during the last two thousand years. On a most elaborate chart which formed a supplement to the address Sir Alexander had set out the leading events and the dates thereof in a most convenient manner, and this chart drew from various members of the section the most flattering eulogiums.

In Section A, Dr. Larmor's address, of which we printed an abstract last week, was attentively listened to by a very good audience, the majority of whom eagerly took their departure to other sections when papers came up for consideration.

Both from the practical and theoretical standpoint, electrical science was greatly to the fore. Perhaps the greatest crowd in either section was that which assembled in A, on Saturday, September 8th, when G was closed, to hear Sir Wm. Preece's popular exposition of his work in wireless telephony, which was followed by the interesting discussion which we are able to print in another column this week, together with a brief account of the paper. The intrusion of something practical and popular into so abstruse a section as A was duly apologised for by Sir William.

Mr. McTaggart in his account of the refuse destructors of the Bradford Corporation, introduced a subject of enormous importance, and his views with regard to the combination of destructor plants and electric lighting installations for town lighting are, as we indicated last week, thoroughly sound.

Mr. J. G. W. Aldridge explained, with the assistance of cinematographe and lantern pictures, a system of electric omnibuses which would travel on the ordinary roads without any special track construction. There were within the minds

D

are brightly polished, or covered with polished steel plates. In treating mixtures containing garnet, iron ore, or minerals of comparatively strong magnetic power, the magnet alone may be provided with a coil. 8 claims.

ment the resistance to be measured is placed in series with the meter resistances and cell, and a fixed shunt is connected across the resistance and meter. 2 claims.



of some of those who were present, serious apprehensions regarding certain points, as will be observed from a perusal of the discussion, but the subject was opportune, and aroused considerable interest.

In the domain of traction we should not omit to mention the paper by Prof. Hele Shaw on the "Resistance of Road Vehicles to Traction," which drew General Webber, Sir W. H. Preece, Mr. Worby Beaumont, and others into a discussion showing how urgently necessary it is that the state of the public roads should be improved, particularly in view of automobile developments. It was mentioned incidentally by Prof. Hele Shaw that a committee of the British Association had been appointed to devote serious attention to the entire question of road resistance.

In his paper on the "Measurement of the Tractive Force, Resistance, and Acceleration of Trains," Mr. A. Mallock described some experiments recently made on electric and other railways—the Waterloo & City electric and the Metropolitan underground electric were specifically mentioned—the object of the experiments being to determine the acceleration, tractive force, and running resistance to which the trains are subject. The appliance used was a short pendulum whose free vibrations are adequately damped. If this is suspended on the moving body it will hang in the direction which is the resultant of gravity and the acceleration which the body at the time experiences; hence the angle which such a pendulum makes with the vertical gives the measure of the accelerations at each instant. In the experiments the pendulum was arranged so as to record its position on uniformly moving paper, on which, at the same time, seconds were marked by an electric clock, and a contact marker, worked from one of the wheels of the carriage, caused a second pen to record each revolution performed by the wheel. The diagram thus obtained gives a direct measure of the speed and acceleration of the carriage. The author showed that pendulum observations, combined with a record of speed and power supplied, offer a simple and effective means of determining the resistance to, and efficiency of, electric or other kinds of motor vehicles.

Sir Wm. Preece, in the discussion, said that the chief merit of this appliance was that, like the diagram of a steam engine, it gave the whole history of the operations that were going on. In the case of the Waterloo line, they had a diagram which told them exactly the action of the train, the influence of the gradients, the effects of curves, the draw-bar pull at every moment, the speed, and, in fact, all the information they wanted to know. He thought that no experiments on electric traction, whether on railways, or trams, or roads, could be considered perfectly complete until they were accompanied with some such method as Mr. Mallock had so successfully employed. The engineer could, by means of it, follow the difficulties, troubles, and frictions of railway trains with the same accuracy that he is now able to watch the performance of the valves of an engine by examining the dial. Mr. Alexander Siemens also added his testimony to the extreme efficiency and usefulness of the Mallock methods. Up to the present it had been a most clumsy affair to measure acceleration of trains. A good deal had been guess work, and everything had depended upon the personal equation of the observers. In the Mallock apparatus they had something absolutely automatic.

Mr. Kershaw's paper led to a brief discussion on the subject of power generation. Mr. Siemens drew attention to one point in the paper, and supported Mr. Kershaw therein, namely, the explosion of the fallacy that existed in many minds that water power was running to waste in England, while abroad they were making good use of it. At Niagara and in Switzerland they used water power because it was inexhaustible and was pretty constant all the year round, a state of things not existent in England. To make provision against this, required such capital outlay as to render it prohibitive.

Prof. S. P. Thompson, who had just returned from his visit to the International Electrical Congress at Paris, gave his hearers the benefit of his investigations of the chief features of large dynamo construction as exemplified in about a hundred different machines which he inspected at the Paris Exhibition. The paper was technical, and the audience was very small. The Professor spoke from a few rough pocket-book notes, and had not even had time to prepare a short abstract.

Mr. Gibbings was not in attendance, so that his paper on "The Design and Location of Electric Generating Stations," was taken as read, and unfortunately there was no discussion upon so important a topic.

Among the other matters worthy of special mention are the papers on the Manchester and Liverpool monorail scheme. These will be found on another page of this issue, together with the discussion, which was not of overwhelming consequence.

It now only remains for us to refer to the two evening lectures. Prof. Gotch, F.R.S., lecturer of physiology at Oxford University, succeeded in delighting an audience of somewhere about 2,000 members of the Association and their friends with an admirable discourse on "Animal Electricity." The lecturer explained the structure of the electrical organs of electric fishes, such as the mormulus, gymnotus, and the malapterurus. After generalisation upon his subject, he set himself four questions, and proceeded to answer them. These questions were:—

1. What is the peculiar structure of the organ which exists in these fishes? How far does it account for their extraordinary powers?
2. What is the character of this electrical shock which the fish can give?
3. What is the character of that comparatively insignificant disturbance which occurred in nerves and in the electrical organs (in his opinion) of a nervous structure?
4. Can those two, the extraordinary shock of the fish and the comparatively insignificant disturbance in the nerves—in spite of their apparent dissimilarity—be probably identical in their formation?

He had a malapterurus on exhibition, and enabled learned and frivolous professors on the platform to test the voltage of its shock. He considered that this fish which was found in the Nile and rivers of Africa was the most interesting in structure as well as in function.

Prof. S. P. Thompson in his Saturday evening lecture to 3,000 or more of the Bradford artisans, brought before them in a popular way, and with a charm of manner which it would be hard to excel, many of the truths regarding the applications of electricity in industrial life which are too unfamiliar with the general populace. He worshipped at the shrine of Michael Faraday, and his hearers were compelled, whether they would or no, to do homage. It would

be difficult to say of whom the "house" thought the most while the lecture was in progress—the Professor, with his very ample equipment of experimental apparatus, or the Michael Faraday whose work was evidenced in every development then recorded, and whose photograph was thrown upon the screen. Prof. Thompson undoubtedly "scored a great success," as they say, and literally brought the house down. He told Bradford to do its duty by the nation and help forward the work of electrical development by not keeping it within the too close confines of municipal enterprise. He brought it home to them, as few others can, that the question of electric power supply is now a national problem, and not one to be tampered with in a too-local spirit. We congratulate the lecturer upon his success, and hope that his words will not be lost upon the minds of the Bradford Corporation and citizens, nor upon the minds of the many throughout the country who read the reports of the lecture.

We have only one matter upon which to strike a discordant note. Prof. Thompson did not say much to the Bradford audience about the question of electric traction, but something that he did say seemed to us to be not only quite uncalled for, but likely to give a wrong impression. He advocated doing things on up-to-date lines at Bradford. So far, so good! Uniformity of gauge, uniformity of motive power, and so on, so that they could run through to all the other towns in Yorkshire without changing and *without any overhead wires*. The overhead trolley system was not much in evidence among the Professor's lantern pictures, if it was shown at all. Perhaps he thought that they had seen enough of it locally to know what it was like. We cannot conceive of any unprejudiced Bradford man going for a trip on the several systems of trams at Bradford, the clumsy and dirty steam cars, the antiquated horse cars, and the clean and rapid electric trolley cars, without being eager for a complete change of the two former systems to the trolley. That, we fully believe, will be the course developments will take when the leases expire in 1903. But coupled with his remarks about doing without overhead wires, the able lecturer said, referring to the next slide, "That car runs along that road without any overhead wires; it runs by surface contacts." . . . . "That, gentlemen, is *my* system of electric traction!" Applause, loud and prolonged. Here, in truth, was a Daniel come to judgment! Where was Dr. Hopkinson? Where were Lineff, Ayrton, and Perry? Where the score of others who had laboured in their day in the surface contact field? The works of all had been consummated in, and the tramway situation saved by, the system of the Professor. Not even a mention was to be made of others. It was only a provincial artizan audience, it is true, and we say nothing more save to ask, "Is it *quite* the thing?"

---

**Contracts for Supply Mains.**

In another column we print a paper headed "Electric Supply Mains," which has been sent to us by the secretary of the Cable Makers' Association, with a covering letter. This paper gives a set of clauses proposed by the Association for use in contracts for the supply of electric light and power mains, and we suppose that an understanding exists among the signatories that these conditions will be insisted upon, and that they will decline to tender for supplies in which conditions less favourable to the contractor are laid down. Apart from the question as to the fairness or unfairness of any particular condition, the attitude of the cable firms, if it is really that which we have read between the lines of their letter, is not unnatural. It is a matter of common knowledge that manufacturers of electric lighting apparatus of all kinds have been seriously hampered by being compelled to quote and work to specifications drawn sometimes with insufficient knowledge, sometimes with irritating and unnecessary detail, sometimes even with sheer injustice. Every principle of equity is outraged by a provision that gives the interpretation of a contract, and that without appeal, to one of the contracting parties; and yet this has been, and is, common to thousands of contracts. That such an arrangement works at all is striking evidence of the essential integrity and practical ability of English commercial men. Vexatious delays in paying for goods delivered, on the ground of default by other contractors, or even of delay for which the engineer is responsible, and the practice of compelling contractors to be responsible for all accidents to cables over whose management they have no control, are opposed to obvious principles of business and economical manufacturing. So the practice, formerly more common than now, of specifying the number and gauge of wires in the conductors, and not merely the total sectional area or resistance, delays manufacture, makes it difficult for the factories to keep adequate stock, and serves no useful purpose whatever. On the other hand, the character of cable work has been such as to cause engineers very great anxiety. Of all parts of an electric supply system the mains are the least accessible for repair, the most difficult to examine, and the most liable to fail without giving any previous notice. It is almost impossible for anyone except a manufacturer to have an intimate knowledge of cables, and no satisfactory method of testing insulating material has yet been devised. Engineers have had to be responsible for putting half of their whole capital into, and trusting the very life of their schemes to, materials of which they can have but little special knowledge, and for testing which they have no satisfactory means. They could not reasonably be expected to do otherwise than in a large number of cases they have done, viz., to throw the responsibility for the success of the cables in every possible way on to the shoulders of those who presumably understand the material, are making money out of its supply, and alone know, and are able to secure, the precautions necessary during manufacture. The question of the guarantee of cables by the manufacturers is full of difficulty, and we do not suppose that any one clause or set of clauses will meet all cases. The document before us limits the manufacturer's guarantee to cases where the purchaser can prove bad material or workmanship; but the burning out of a fault usually removes all indication of its cause, and unless the purchaser can find defects in the remaining cable near the fault, and establish a probability that the fault was due to a similar defect, he will in most cases have to bear the loss himself, to whatever cause it may have been due. Now it may be urged that a purchaser can fairly claim that if a cable has been laid with due care, in a way and under conditions approved by the manufacturer, the responsibility for subsequent failure rests primarily with the guarantor. Questions of this kind are best dealt with by negotiation. The keen competition between the different firms has perhaps hitherto placed them individually at a disadvantage in their dealings with consulting and municipal engineers, and they have sometimes been called upon to meet losses inequitably, but the existence of an agreement among themselves as to the terms they will or will not accept, appears to reverse the situation. It will be interesting to see what the practice is some years hence.

## OVERHEAD CONSTRUCTION, WITH SPECIAL REFERENCE TO GUARD WIRE.

By SYDNEY WOODFIELD.

I have read with a considerable amount of interest the paper Mr. Quin read before the M.E.A., and also an article in your issue of August 31st on the same subject. I can fully endorse the statement of the author of the above article as regards guard wires, viz., that they are a nuisance, and in many instances they are greater dangers than those which they are supposed to avert. He also states that the usual method of guard wiring is fairly cheap to erect, but that maintenance is a more or less constant drain on the revenue, and one can quite believe this, seeing the construction in certain towns. Surely it would be wise to sink a little more capital in the much reviled guard wire!

Let us now look into the cause of the accidents, the majority of which are caused by the trolley jumping the trolley wire and getting caught in the guard or span wires.

In the early days of electric traction in this country, when the trolley jumped the wire, there was nothing to prevent it taking almost a vertical position, thus giving it every chance of becoming entangled in the overhead wires, or bent nearly double by a bracket arm; but in modern trolley standards a stop is provided, so that should the trolley leave the wire, it can only take a position 1 to 2 feet above the normal, thus preventing to some extent the trolley catching in the wires, although the pole may still swing around and come in contact with a pole or its scroll work. Several devices have been worked out to let the pole fall 2 or 3 feet should the trolley jump the wire; one of them was described in your issue of February 2nd, 1900, although, apparently, it did not prevent the trolley pole swinging round. No information is to hand regarding the working of the devices, but there is no reason why such schemes should not work well. It may here be asked, why limit the distance of the guard wire above the trolley wire to 2 feet, when surely it would be an advantage to increase it to 3 or 4 feet, which would lessen the chance of a trolley catching it, and would minimise the risk of a broken telephone or telegraph wire coming in contact with it.

My experience of these wires falling across the guard wire is, that the free end of the fallen wire entwines itself around the guard wire, although there are instances where it becomes fixed in some position and remains so, permanently short-circuiting the trolley wire to the earthed guard wire. Would it not also be preferable to erect the guard wire vertically over the trolley wire, so as to still further provide against the trolley catching it? for very rarely does a fallen wire remain hanging across the guard wire, and this, I take it, is the reason of the guard wire being placed outside the trolley wire.

The reason of the trolley jumping the trolley wire appears to be due to bad construction and inferior design, also to reckless driving on the motorman's part.

Some of the older systems were constructed too much on the American principle, which, although suitable for a fixed trolley, is totally unsuitable for a swivelling head and the trolley line at a distance of 12 to 15 feet or more from the centre of the track. Again, frogs and crossings as used for the fixed head are also not suitable for a swivelling head, and it is only in quite recent years that frogs and crossings have been developed for the latter. Shallow grooved ears with lugs at the ends are being gradually replaced by deep grooved ones without lugs, the advantage of the latter to the smooth running of the trolley is indisputable. Ears are now being made up to 42 inches, these being used around curves. "Pull off" wires are being superseded by placing more poles around curves with the long ears bent *in situ*, thus doing away entirely with many wires crossing the street and standing as a menace to the first trolley that jumps the wire, besides improving the appearance. All the causes mentioned, and many others beside of the same nature, are responsible for innumerable mishaps to the overhead lines.

In fig. 1 is given a section through a grooved trolley wire, a form which is being largely used by the General Electric Company, of Schenectady, and which is giving immense satisfaction to all those who have it in their employ. This wire is manufactured in three sizes, viz., 2/0, 3/0 and 4/0 B. and S., the actual diameter being slightly increased to compensate for the material taken out by the grooves. This wire possesses all the running advantages of a figure eight wire, but without the disadvantages as regards handling, as the section is nearly symmetrical, and consequently it is just as easily erected as an ordinary round wire, whereas a figure eight one, being of somewhat irregular form, the elongation

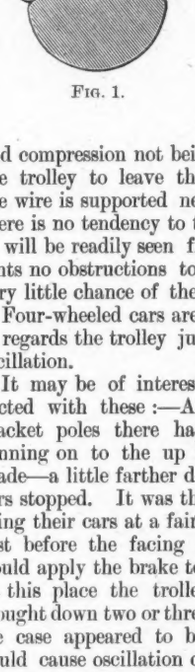


Fig. 1.

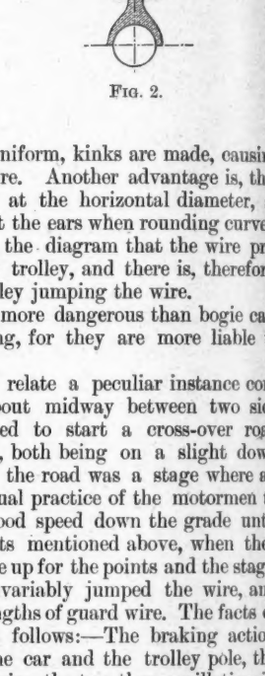


Fig. 2.

and compression not being uniform, kinks are made, causing the trolley to leave the wire. Another advantage is, that the wire is supported nearly at the horizontal diameter, so there is no tendency to tip at the ears when rounding curves. It will be readily seen from the diagram that the wire presents no obstructions to the trolley, and there is, therefore, very little chance of the trolley jumping the wire.

Four-wheeled cars are far more dangerous than bogie cars as regards the trolley jumping, for they are more liable to oscillation.

It may be of interest to relate a peculiar instance connected with these:—At about midway between two side bracket poles there happened to start a cross-over road running on to the up road, both being on a slight down grade—a little farther down the road was a stage where all cars stopped. It was the usual practice of the motormen to bring their cars at a fairly good speed down the grade until just before the facing points mentioned above, when they would apply the brake to ease up for the points and the stage. At this place the trolley invariably jumped the wire, and brought down two or three lengths of guard wire. The facts of the case appeared to be as follows:—The braking action would cause oscillation of the car and the trolley pole, the latter transmitting it to the wire, the two then oscillating in synchronism. When the car, however, had proceeded a few yards further on it came to the rigid ear; the pole and wire being no longer able to oscillate in synchronism the trolley would jump the wire. It was actually found afterwards that if the brake was applied within two or three yards of the facing points the trolley could be made to jump the wire in nearly every case, whereas, if applied a yard or so higher up the line, the trolley would rarely jump; evidently the oscillations had been sufficiently damped by the car springs. To show how careful construction and design may obviate accidents, I may here mention that some little time back I travelled on the top of a car for about three-quarters of a mile with the trolley running in the wrong direction, the conductor at the terminus having failed to turn it and put it on the right wire. Although two or three nasty curves were passed at about 8 to 10 miles an hour, it never left the wire; luckily, no other car was met proceeding in the opposite direction. On this line all ears on the straight are 18 inches long, and around curves they vary from 24 to 42 inches, depending on the radius of the curve.

Concerning the supports of the guard wires themselves, it is not good practice to make the top half of the bracket hanger-clamp serve the double purpose of supporting the hanger and guard wire standard, for should anything go wrong with the trolley wire—for instance, if it snapped, the whole bracket clamp would turn around owing to the tension on either side not being balanced (assuming, of course, that the trolley wire still held on to the ear), and this

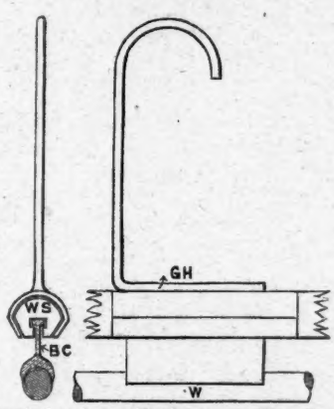
would cause the guard wire to break, or if it did not, the tension on the one side being very small, the sag would increase till the guard wire would come in contact with the trolley wire which might still be alive, probably burning it through, and thus causing further mischief.

It has also been found that in straining up the guard wire, owing to the length of the leverage the bracket hangers themselves are pulled out of the vertical, thus causing a nasty kink in the trolley wire. A few of the first tramways in this country insulated the guard wire, this, was far preferable to earthing it, but on the score of safety, it should be earthed.

It is not necessary to actually bond the guard wire to the pole, and the pole to the rail if it runs for some distance, making a moderate earth at each pole, but where very short lengths are used, say, between two or three poles, it should be earthed directly to the rails, as if the wire did come into contact with the live wire, the earth would not be good enough to knock out the station circuit-breakers, although sufficient current may be passing along the guard wire as to make it almost red hot, and the paint may be peeling off the poles themselves because of the heat, the ground round about the pole being charged so as to render it dangerous to pedestrians and horses. This has occurred more than once.

If guard wires are to be erected at all, let them be done in a more substantial and workmanlike manner than they are at present; let them be put up just as permanently and strongly as the trolley wire itself—in fact, as if they had got to stand the same amount of strains and knocking about.

A good sized wire to use is a 7/17 S.W.G. galvanised mild steel strand, having a breaking load of not less than 1,400 lbs. and an extension of 4 per cent. on 12 inches; the latter is most important, owing to the peculiar strains




G H, Galvanised hook; W S, Wood strip; B C, Brass clip; W, Wire.

FIG 3.

encountered. Particular attention should also be paid to the galvanising. This consists in coating the steel wire with a thin layer of zinc, which oxidises slowly in air, forming a compact layer of oxide, which prevents further oxidisation, thus protecting the steel, which, if left to itself, would oxidise in a less compact form, such processes still continuing would finally eat the wire through.

A good test for galvanising consists in dipping a sample of the wire into a saturated solution of blue vitriol (copper sulphate, $Cu\ SO_4 + 5\ H_2\ O$), allowing it to remain immersed for one or two minutes, then taking it out and drying it so that it is perfectly clean, repeating this process half a dozen times or so. If the galvanising is not perfect the iron in the steel wire will come into contact with the copper sulphate, which will dissolve it, the copper being precipitated from the solution at the same time in a spongy mass on the wire.

After erection the guard wires should be rubbed down with vaseline, as hydrochloric and sulphuric acids, which are always present in the air to some extent in towns, act on the zinc, and sulphuretted hydrogen, traces of which are invariably present in populated places, converts the zinc into sulphides.

In place of guard wires a method has been practised in Liverpool, Leeds, and Aberdeen of using a wooden strip supported by means of clips from the trolley wire itself. This idea seems to have emanated from Germany, where it is used to some extent. The strip is usually made of canary wood or kauri pine, the latter being preferable, as it is less likely to warp, although the former is more often employed, owing to its cheapness, and the clips which are placed at about 3 feet centres, are soldered to the trolley wire. The strip should be thoroughly painted with P. and B. paint, which is an excellent protection against deterioration. Fig. 3 shows a section and side view of guard strip as used at Leeds, and fig. 2 a design for use under bridges.

Considerable trouble seems to have been encountered with the clips, owing to the continual jarring and knocks which they receive from the trolley wheel, causing them to come unsoldered, thus seriously interfering with the smooth running of the trolley wheel.

Comparing figs. 1 and 3, it will be seen how readily these clips could be fixed to the grooved trolley wire by means of a similar arrangement to that shown for supporting the wire. The guard strip gives the trolley wire an exceedingly heavy appearance, and one cannot help being struck by the excessive noise which it causes as the trolley wheel passes. Considerable strains may be put on the wire, owing to the weight which would have to be encountered when ice and snow accumulated. Where this system is employed a considerable factor of safety should be allowed, as in winter the tension would, of course, increase, owing to the dip decreasing, and at the same time the ice and snow may add enormously to the weight per unit length. Again, a far bigger surface would be exposed to the wind—a fairly high wind may give a pressure of 30 lbs. per square foot—so that we may easily get three or four times the normal tension on the wire.

Guard wires have been practically abandoned in the States for some time past; and even on transmission lines, where guard wire is erected for protection against lightning, it has been found to be a continuous source of danger. The wires erected on the Buffalo—Niagara Falls transmission lines have been taken down, decreasing the number of short circuits, and with no bad results from lightning.

Considering the question from all points, there appears to be always the danger of accidents and interruptions wherever guard wires are used, such accidents and interruptions being more numerous on systems employing the side bracket construction than on those using the span wire system, where the trolley wire is practically over the centre of the track. Experience suggests the following points with regard to the erection of guard wire:—

1. That they should be erected 3 to 4 feet above the trolley wire.
2. That they should be vertically over the trolley wire.
3. Where used in one continuous length, say, over a quarter of a mile, there is no necessity to directly earth to the rails, provided the wire is in no way insulated from the bracket arm.
4. Where used in short lengths, say, to protect two or three spans of trolley wire, it should be directly earthed to the rails.
5. That it should not be used around curves where "pull-off" wires are necessary for the guard wire, guard strip being far more suitable.
6. That great care should be exercised in anchoring, it being preferable to anchor three or four spans further ahead, where there is any liklihood of the trolley jumping.
7. That stronger and more durable material be employed, and greater care be exercised in erection and examination.
8. That the bracket hanger clamp should not serve the double purpose of supporting the guard wire standard and the bracket hanger.

## MOLECULAR CHANGES PRODUCED IN MATTER BY ELECTRIC WAVES.

THE paper by Dr. Jagadis Chunder Bose, read before the Royal Society in February, marks a great advance in our knowledge of molecular physics, and the intimate connection between electric disturbances in the ether and chemical reactions.

The true theory of the so-called "coherer" for the detection of electric waves has been revealed by Dr. Bose's experiments, and has been found to be very different from that originally propounded by its discoverers. The reduction of resistance in metal filings under the influence of electric waves has been hitherto attributed to a kind of electric welding caused by spark discharges which take place between the particles. The coalescence of water and mercury drops in Lord Rayleigh's experiments apparently lent much support to the theory of electric welding. But, as Dr. Bose points out, on this theory *all* imperfect contacts should exhibit *diminution* of resistance when subjected to electric radiation. He has, however, found, on carrying out a systematic investigation of contact sensitiveness on metals, that there are many substances, of which potassium may be taken as a type, that exhibit an *increase* of resistance. Besides potassium, a considerable number of elements, and also of compounds, have been found which exhibit a similar action.

Dr. Bose's theory is that the change of resistance produced in a substance by the action of electric waves is due to the formation of allotropic modifications. He considers that it is identical with the photographic action of the light

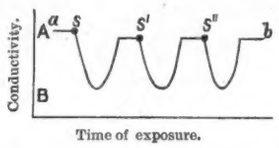



Fig. 1.—Curve for Potassium.

on sensitive substances, on which latter subject he promises a future paper. The name which Dr. Bose proposes to substitute for "coherer" is "molecular receiver."

The following are the hypotheses made by Dr. Bose to explain the action of electric radiation on matter :—

1. That electric radiation produces molecular change or allotropic modification in a substance.

2. That, starting from the original molecular condition A, the effect of radiation is to convert it to a greater or less extent into the allotropic modification B. It follows that this change from one state to the other must be accompanied by a corresponding change in the physical properties of the substance.

3. As one of the properties of a substance is its electric conductivity, any allotropic changes produced by radiation

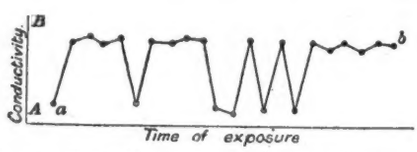



Fig. 2.—Radio-Molecular Oscillation Curve for Magnesium.

should be capable of being detected by a variation in the conductivity of the substance.

4. As a molecular strain is produced during transformation from A to B, at a certain stage there may be a rebound towards the original state A. Thus, after the molecular change from A to B condition has reached a maximum value, the further action of radiation may be to reconvert to a more or less extent, B to A, this reversal of effect being indicated by a corresponding electric reversal.

5. That the ultimate loss of sensitiveness, known as "fatigue," is due to the presence of the radiation product, or strained B variety, along with the A variety, the opposite effects produced by the two varieties neutralising each other.

Dr. Bose then deals with the experimental evidence in support of these hypotheses.

It is well known that light, which is a form of electric radiation, produces allotropic modifications by its action on certain substances; for instance, yellow phosphorus is converted into the red amorphous variety, and soluble sulphur into a variety insoluble in bisulphide of carbon. There are probably many more such instances which have escaped detection with the means at our disposal. Dr. Bose points out the great value and delicacy of the tests which are obtained by noting the changes in electric conductivity, and this method may in future put a new and more powerful instrument for research in the hands of chemists and molecular physicists. In his paper Dr. Bose gives a number of curves showing the relation between conductivity and time of exposure in various substances. The time of exposure was measured by counting the individual flashes of radiation due to the interruption of the primary current in

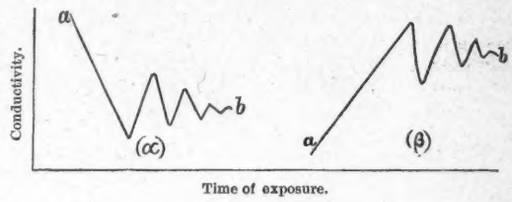



Fig. 3.—"Damped" Molecular Oscillation.

the Ruhmkorff coil by a tapping key. The conductivity of the substance at a given moment was inferred from the deflection of the galvanometer in circuit with the receiver. In order to expedite the reversals, the incident radiation was made very strong.

The following curves show the principal types of substances to be met with.

1. Substances in which the B state is unstable under the given conditions; the B state will therefore only persist during the action of radiation, the substance relapsing into the original condition on the cessation of radiation. Two cases are possible, first, when the substance is positive; second, when the substance is negative.

The latter case, where the resistance is increased by electric radiation, is exemplified by potassium. In the curve, fig. 1, for this substance A and B represent the two molecular states. The substance being negative, A is more conducting; *a* represents the conductivity of the fresh specimen; the thick dots, S S', the individual flashes. It may be seen that the effect of radiation is to produce a sudden diminution of conductivity. The substance, electrically speaking, is highly elastic, and the limit of its elasticity is also very great. With the majority of substances, however, self-recovery is only possible when the narrow limit of elasticity is not exceeded.

2. Substances in which the radiation product is somewhat stable; the successive conversions from A to B, and from B back to A are supposed to be complete. We have an approximation to this condition in magnesium, which, under proper adjustments, shows successive complete reversals for a long time. The substance after a time, however, exhibits the effects of fatigue.

The curve given in fig. 2 clearly exhibits the reversals. The receiver was so adjusted as to give a deflection of five divisions. The first flash of radiation produced a positive deflection of 90 divisions (magnesium being positive); the second flash produced a further deflection of five divisions, the third flash produced a *negative* deflection of five divisions, the fourth flash produced + 5, the fifth flash gave − 90, and the sixth flash + 90. The reversals then followed each other almost regularly, till the substance became insensitive. All these changes are shown by fig. 2.

3. Lastly, we have a class of substances where the conversion from one state to the other is not complete. Here, again, we get two sub-divisions, owing to the distinction between positive and negative substances.

Taking first the case of a positive substance (see fig. 3) ($\beta$), the original conductivity of which is represented by *a*, the action of the first few flashes of radiation would be to produce a great increase of conductivity by the formation of B variety; the next flashes convert B back to A, but not completely, and the negative deflection will be less than the previous positive deflection. Owing to this "damping" effect, the oscillation curve will approximate to a logarithmic decrement curve. After a series of reversals the oscillation dies away, and the substance becomes almost inert. A glance at

the hypothetical curve to the right shows that at the inert stage, *b*, the substance, as a whole, becomes more conducting than the fresh specimen, *a*. The opposite is the case with negative substances (see fig. 3 (*a*)).

A curve obtained from a positive compound substance showed remarkable regularity in its oscillations.

Fig. 4 shows the curve for iron. The first diminution of resistance is too great to be properly represented in the diagram. The inert stage, *b*, is, as in fig. 3 (*β*), more conducting than *a*.

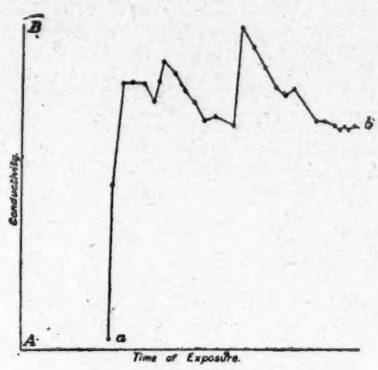



Fig. 4.—Curve for Iron.

Fig. 5 shows the actual curve obtained from arsenic (a negative substance). It will be observed, as in fig. 3 (*a*), that the substance in the fatigued state is, on the whole, less conducting than in the fresh condition.

It is evident that, in substances exhibiting damping, two opposite electric conditions are induced in fatigued specimens. At the inert stage the rate of mutual conversion from one state to the other probably becomes equal, and the apparent fatigue is thus not due to the absolute want of sensitiveness of the constituent varieties, but to the opposite reactions of A and B balancing each other.

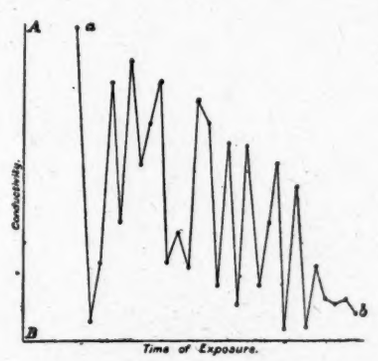



Fig. 5.—Curve for Arsenic.

Mechanical disturbance or gentle heating restores the B variety to the A variety, and the sensitiveness to the substances. Curves showing these effects are given in the paper, for a positive substance (iron) and a negative substance (arsenic). In the case of the former the conductivity is diminished by the disturbance; in the case of the latter it is increased.

Dr. Bose, in a paper read at the recent meeting of the British Association, has shown the bearing of his remarkable discoveries on nerve and muscular action. We hope to deal with this paper in a future article. Considerable additions are likely to result to our knowledge of hitherto obscure physiological actions, and of the application of electricity for curative purposes. Dr. Bose's discoveries, interpreted in the light of J. J. Thomson's electron theory, are likely soon to lead to great advances in our knowledge of chemical reactions, and the relations of electricity to matter.

## THE DISPOSAL OF TOWNS' REFUSE.

By ED. C. DE SEGUNDO, A.M.Inst.C.E.

The paper read by Mr. McTaggart at the recent meeting of the British Association on the disposal of house refuse in Bradford is a valuable and important contribution to our knowledge on this subject. It deals in an impartial and practical manner with the problem of the disposal of towns' refuse, and gives an account of the development of the "destructor" method of coping with this all-important matter in Bradford. From a perusal of the paper, most of which was published in last week's issue of your journal, it will be seen that the Bradford Corporation do not appear to be wedded to any one type of destructor, but that more than one type has received a thorough test as a cremator of refuse, and it will be noted that Mr. McTaggart lays great stress upon the true function of the refuse destructor, namely, to provide a means for the disposal of all refuse in an efficient sanitary manner. The analyses of the chimney gases show that at Bradford combustion has been complete.

In the Electrical Review there recently appeared an article in which the subject of towns' refuse and its disposal was treated academically, and by inductive reasoning the conclusion was arrived at that, to work a destructor at a high degree of efficiency as a means of completely consuming refuse and simultaneously of maintaining a constant evaporation of water and pressure of steam proportionately to the calorific value of the refuse, was exceedingly difficult, if not practically impossible of achievement, and the writer of the article stated that within his knowledge there was not a single instance of electricity being satisfactorily and economically generated from destructors where refuse only was used as a fuel. This statement, the meaning of which was no doubt clear enough to all impartial minds, did not commend itself to certain gentlemen interested in these matters, who forthwith wrote to complain of the ignorance of the author of the article, and of the pessimistic attitude adopted generally by this journal towards the subject of destructors.

A spirited correspondence ensued, and the matter dropped, until a further letter finding fault with some remarks in the journal upon a destructor trial seems to have called forth a leading article upon the subject, in which the views of this journal are set forth in unequivocal terms.

Mr. McTaggart's paper, and the views he expresses are interesting in that if he held a brief for the writer of the articles above alluded to, he could hardly have arranged a more complete and practical confirmation of the views set forth in these articles. For instance, in deciding upon a scheme of refuse destruction, he says that preference was given:—

1. To the design of furnace which is calculated to give the highest destroying efficiency, taking into consideration the cost of working and repairs.

2. To the scheme which is calculated to give the highest evaporative efficiency bearing in mind the fact that the destruction of refuse without nuisance is the first consideration.

With regard to the evaporation, this comes out to 0·882 lb. water from and at 212° F. per lb. of refuse burnt, but Mr. McTaggart points out that this could be improved were the setting of the boilers different. Of this there is little doubt, as the temperature of the gases at the bottom of the chimney is 1,000° F.

Mr. McTaggart's strongly worded remarks upon so-called destructor tests of one, two, or three hours' duration have already been quoted in last week's issue. It is needless to point out that it is extremely difficult to end the trial with the fire in exactly the same condition as when the trial started, even when using coal as a fuel. With refuse as a fuel it is well nigh impossible, and the difference in the amounts of fuel on the grate at the beginning and end of the trial may, in a short trial, be a considerable proportion of the fuel consumed.

Unfortunately, Mr. McTaggart does not state what is the percentage of moisture in the van refuse. Judging by the amount of residuals (29·36 per cent.), the refuse—if an average sample of Bradford refuse—must have been very dry. It would be interesting to know whether the refuse is received in this condition all the year round.

Having regard to the claims of Mr. Goodrich and Mr. Stanley Clegg, so recently published in the ELECTRICAL REVIEW as June of this year, it is interesting to note Mr. McTaggart's statement that while "the utilisation of the steam produced at our various refuse destructors in a profitable manner is a subject to which the Cleansing Committee have given every consideration," there is no reference, even indirect, in Mr. McTaggart's paper to the value of refuse as a fuel for the generation of current for electric lighting purposes, and, in his reply to the discussion, Mr. McTaggart expressed very decided opinions on this subject. Now as Bradford has been concerned with refuse destructors since 1880, it may reasonably be inferred that considerable experience on the subject of the calorific value of refuse has been gained during these 20 years, more especially as the Bradford Corporation has undoubtedly selected an apparatus which may be said to be in the very front rank of efficiency for this purpose.

It must be so obvious to any thinking mind that towns' refuse, from its very name, involves great fluctuation in calorific value, in contained moisture and in quantity delivered, that it really ought to be unnecessary to seriously consider the why and wherefore of this in a technical journal. The broad and far-reaching assertion recently made in the correspondence on this subject, that refuse capable of evaporating 1·62 lbs. of water from and at 212° F. per pound was *below* the average of refuse seems to bear its refutation on its face; for if this class of refuse is *below* the average, the performance of average refuse must be higher, say, 2 lbs. water per pound, and if this be taken as the *average*, then some refuse must be capable of evaporating at least 3·5 lbs. water per pound, since it is known that much of the refuse dealt with only evaporates 0·5 lb. of water or less per pound.

I have closely followed this subject for the last 10 or 12 years, and as far as can be gathered, the character of refuse has not materially changed since 1888, when Colonel Codrington's report to the Local Government Board was issued. It is therefore difficult to see how improvements in design, which enable the heat given out by the refuse to be more completely utilised, can, without auxiliary apparatus, correct the results caused by the wild fluctuations in the character, quality, and quantity of refuse throughout the kingdom; and while not disputing the fact that, under certain conditions, the heat of combustion of refuse may be profitably employed for the production of electric light, the suggested use of refuse as a substitute for coal in a central electric generating station, where every pound passing into the furnace is relied on to evaporate over 1½ lbs. of water in the same time, is sheer nonsense.

It is to be hoped that Mr. McTaggart will add to the great usefulness of his work by continuing these two-week tests at other seasons of the year. It would be in the highest degree valuable to have a record of such tests made, say, every three months over a period of years.

## CURRENT SPECIFICATIONS.

### XXIX.—SUNDERLAND EXTENSION PLANT.

SUMMARY.

*Extent of Contract.*—The supply of *two* 125-KW. steam dynamos and *one* 275-KW. steam dynamo, with option to purchaser to order *two* additional 275-KW. sets without alteration in price at any time within *twelve months* of first order.

*Type of Engines.*—The two 125-KW. size to be compound high speed of the *Belliss enclosed or other approved type.*

The *one* or *three* 257-KW. size to be three-crank triple expansion high speed, of the *Belliss enclosed or other approved similar type.*

*Type of Dynamo.*—Left oper. to tenderer.

*Steam Pressure Available.*—155 lbs. per square inch at engine stop valve.

*Vacuum Obtainable.*—25 inches measured close to the engine, to be obtained from separate condenser, not included in contract.

*Speed of Combinations.*—To be about 350 revolutions per minute for the 125-KW. sets, and 300 revolutions per minute for the 275-KW. sets.

*Overload of Combination.*—*Twenty-five per cent.* for one hour immediately after full load run for 12 hours.

*Permissible Temperature Rise.*—Not to exceed 70° F. above surrounding atmosphere in any part of armature or field magnet winding when measured thermometrically after 24 hours continuous run at normal full load.

*Voltage of Dynamos.*—To be capable of working without sparking at any voltage between 220 and 260 volts at constant speed.

*Efficiency of Combination.*—For 125-KW. set: Not to be less than 88 per cent. at full load and 75 per cent. at half load. For 275-KW. set: Not to be less than 92 per cent. at full load and 80 per cent. at half load.

*Guaranteed Steam Consumption.*—See below.

*Specified Date of Completion.*—The two 125-KW. sets and *one* 275-KW. sets within ten months of date of order, the remaining *two* 275-KW. sets, if ordered, within 12 months from date of instructions to put them in hand.

*Penalty for Late Completion.*—£30 per week.

*Terms of Payment.*—Ninety per cent. upon the engineer's certificate of satisfactory completion and test at station; 10 per cent. at end of 12 months period of maintenance.

*Stipulations as to Removal of Foreman.*—Fairly satisfactory. See comments below.

*Stipulations as to Wages Paid to Workmen.*—See comments below.

*Arbitration Proposals.*—Unsatisfactory in present form. See comments below.

*Date on which Tenders are Due.*—September 21st, 1900.

---

This specification has been prepared by Mr. J. F. C. Snell, A.M.I.C.E., the borough electrical and tramway engineer. It asks for the first instalment of generating plant for the new station, which the rapidly growing requirements of the town for electric energy have rendered absolutely necessary.

It will be noticed that contrary to usual practice in a combined lighting and traction station, the dynamos are to be wound for 220 to 260 volts in place of the usual 500 to 550 volts, and that they are specified to be simply shunt wound.

The combined efficiency and steam consumption guarantees asked for are of a most stringent character. The larger set is to have not less than 92 per cent. *combined efficiency* at full load, and the smaller set 88 per cent.

There will be presumably the usual 5 per cent. margin upon the following figures for tests taken when the engines are running new and stiff, but even then they are very low, no superheat being allowed, steam pressure for triple expansion work being only 155 lbs. square inch, and the vacuum being 25 inches.

| Lbs. of water *per KW.-hour.* .. | Full load. | ¾ load. | ½ load. | ¼ load. |
|---|---|---|---|---|
| 275 KW. triple expansion ... | 23·7 lbs. | 24·8 lbs. | 25·5 lbs. | 26·5 lbs. |
| 125 KW. compound... ... | 28·5 lbs. | 30·0 lbs. | 31·5 lbs. | 33·0 lbs. |

The reservation of the right of the Corporation to order two additional 275 KW. sets at a price to be stated by the tenderer in his offer, seems to us to be capable of a very one-sided interpretation. Prices may vary greatly within that period; if they rise it will be decidedly to the advantage of the Corporation to exercise their power, and buy at present rates, while if they fall they have the option, if they care to exercise it, of calling for fresh offers, and taking advantage of the lower prices then ruling in the market. We think that a clause should be added, either granting to the contractor the option of revising prices in accordance with ruling rates, or else binding the Corporation to purchase at present rates if they want the sets at all.

The wages clause reads as follows:—

> The contractor shall undertake to pay all employés engaged by him in the carrying out of the contract wages in accordance with the scale drawn up and agreed to by the employers' and the employés' representatives in the district in which the contract is being carried out. These conditions to be equally binding on a sub-contractor. In the event of any breach of the aforesaid covenant, the Corporation reserves to itself the right to determine the contract.

Although in practice it could probably be accepted by every manufacturer of high standing, we dislike the working of this clause, since it concedes the principle of that "collective," as opposed to "individual" bargaining which is the cause of much of the antagonism between masters and workmen so destructive to our national industrial prosperity.

Clause 73, which deals with the engineer's power to stop work, reads:—

> Should any circumstances render it necessary in the opinion of the Corporation or the engineer to delay or postpone the commencement or execution of the whole or any part of the works, the Corporation or engineer shall be at liberty to do so, in which event an equivalent extension of time to complete the works will be allowed the contractor, and the date for the completion of the contract shall be extended for a period *equal to the time of such delay or postponement*, without prejudice to the contract.

This may unwittingly act in a very unfair manner on the contractor, for while he gets no monetary consideration for

the delay, only an equivalent postponement of the date of completion, it may involve him in an unexpected large outlay. All who have organised bodies of workmen for a job in a town far from one's headquarters know the cost of not being able to proceed with the work in hand. It cannot be compensated for by any mere alteration in the date of completion, and we consider that a contractor is entitled to ask for any extra sum which a postponement of the work by the engineer may cause to be incurred.

The maintenance clause as worded goes beyond the standard clause, which demands that the contractor shall maintain the plant, fair wear and tear excepted, against faults caused by defective workmanship or material.

The contractor is by the wording here adopted:—

> To maintain and uphold the whole of the works comprised in his contract, together with such further works as may be ordered by the engineer as aforesaid, *in thorough, good and substantial condition and repair for a period of twelve months from the date of the engineer's certificate of satisfactory completion*, and *leave them at the end of that time in good and efficient working order and repair*, to the entire satisfaction of the engineer, to be shown by a certificate in writing from him to that effect.

We have again to call attention to the limitations of the arbitration clause. It is strange how slowly the necessity for an ultimate right of appeal by a contractor to an independent authority is appreciated by the average town councillor. Because in many cases substantial justice is done, often as a favour, he considers that there is no harm done in limiting in one direction or another, the standard arbitration clause.

The references to arbitration are in this specification contained in three clauses, and in order to understand the position we must reprint them all.

Clause 67 reads:—

> *Should there be any doubt or obscurity as to the meaning of the specification*, the contractor must set forth the particulars thereof and *submit them to the engineer*, in order that *such doubt or obscurity may be removed before the signing of the contract. If any misunderstanding should arise during the progress of the works, the decision of the engineer as to the meaning of any dimension, clause, word, sentence, or otherwise must be taken as final.*

In Clause 82 we find:—

> The contract is to be conducted under the superintendence and to the satisfaction of the engineer, and *in all cases of difference of opinion between the Corporation and the contractor* (except as set forth in Clause 83), *the decision of the engineer shall be final and binding upon all parties.*

While Clause 83 states:—

> Provided that in case of any dispute or difference arising between the Corporation, or the engineer on their behalf, and the contractor as to any of the points herein below set forth, such dispute or difference shall be referred to the arbitration and decision of some person appointed by the President of the Institution of Civil Engineers for the time being, and the decision of such referee shall be final and binding upon all parties, and shall be made in writing, and such decision or award may be made a rule of in any of Her Majesty's courts of law, and proceeded upon accordingly. The costs of and attending such arbitration, reference or award, shall be absolutely in the discretion of such referee. The matters which may alone be submitted to such referee are: (1) As to whether the engineer has allowed a reasonable extension of time for the completion of the contract, in consequence of any strike or lock-out, or of any additional works being ordered; (2) as to the cost of any alterations, variations, extensions of, or diminutions from, the works included in the contract, and which are not determined by the priced-out bills of quantities or schedule of prices; (3) as to any damage to life or property attributable to the operations carried on under the contract.

It will be seen that all technical questions are reserved to the decision of the engineer. He alone is to interpret the meaning of the specification. It may be argued that the contractor may, by Clause 67, raise all doubtful questions before signing the contract, and that working with a fair-minded engineer there is little or no risk in accepting a clause limited to such an extent as this.

The statement may be true, but we have to maintain our position on principle, and not allow personal considerations to influence us. These limitations are, in our opinion, wrong in principle, and should be withstood by tenderers. The insertion of a clause giving a free right of appeal to arbitration to either purchaser or contractor, would not necessarily be the cause of increased friction between the parties, but it would give to both a feeling of confidence that, if they considered themselves in any way aggrieved, they could, if they liked, compare their differences in this manner.

## MALLEABLE IRON FOR TRAMCAR DETAILS.

An important detail in the construction of an electric car is the trolley base. This commonly consists in a pin carried by a boss cast upon a circular plate about a foot in diameter. This plate is bolted down to the top of the car by very insufficient bolts, but the weakest part in the structure is the plate itself. It is of cast-iron about $\frac{3}{8}$th inch thick, and the central pin boss is cast upon it with an absolutely square corner, without the slightest fillet, and with no ribs. Any slight excess of stress upon the trolley simply tears the boss out of the plate with a fracture that runs all round in the sharp corner. It is said that all cast-iron about an American tramcar is malleable. We have noticed a good deal that had been to some extent through the process of malleableizing, but the general experience is that the work has been very badly carried out, and the castings are also very faulty both in blow holes and in the absence of proper fillets, and are not such as ought to be turned out of any foundry possessing such excellent raw material as American foundries are able to avail themselves of. Large numbers of breakages occur in parts supposed to be malleable, and while we have heard so much about the excellence of American malleable iron and of its cheapness, and have seen much excellent work in small articles, we must confess our surprise to find such inferior material put into the details of cars. Some of what we have seen seems to have been very far deteriorated below the quality of decent cast-iron, and we are led to the belief that the process of decarburization, when only partially carried out, is positively harmful. We cannot say from further knowledge if this is so, but it is certain that much American car work gives support to this view, and that the process is most inefficiently applied. Now it is certain that, completely carried out, the process adds immensely to the toughness of a casting. Good malleable cast-iron can be bent and forged. It chips and files very like steel, and can be applied to uses where great strength is necessary, though, however good, we should never apply it to the parts of anything so important as, say, a steam boiler. Yet supposed malleable iron in tramcars snaps like the worst of cast-iron, and the trolley baseplate is but one of many details that have been broken under our notice.

There is no excuse for this, nor for the sharp unfilleted corners. The process of casting is one of common knowledge, so is the subject of fractures due to sudden alteration in the mass of a casting, and the intensifying effect of sharp corners, while the chemistry of malleable iron processes is also not a secret. Moreover, some of the best books on foundry work are American, and the literature of iron founding in American technical journals has always been good. We believe that the process of malleablizing requires three weeks for all such castings as come into the construction of a car. If this is so, it is certain they do not get it. Some of the broken parts we have seen appear to have been heated in the open instead of in closed boxes, and to have become burned rather than decarburised. There is some doubt, according to Stanford, whether decarburisation really occurs. Stanford states that the castings to be treated should be of white cast-iron—all the carbon being combined. They are packed in cast-iron boxes with the material to treat them, usually iron oxide, said to be of use only to keep the castings in shape when hot. The time of heating is five days, with a subsequent slow cooling, and that the cost is from $\frac{1}{4}$d. to $\frac{1}{2}$d. per lb. Sulphur in the iron delays the process, and the effect is said to be that the carbon in the iron ceases to be combined, and is left in the graphitic state, and that at most the outer skin alone is decarburized. According to Stanford the tensile strength is doubled by the process, and the elongation of 6·6 per cent. demonstrates very considerable ductility. The iron is, in fact, doubly strong for static loads and many hundred times as strong against shock.

Thurston says cast-iron of the best quality should be employed, preferably packed in hematite ore or peroxide of manganese, and that with large pieces "many days" are required. He differs from Stanford, who says the material

will weld, for he denies it this property, but credits it with the strength but not the ductility of wrought-iron. Evidently Thurston believes in the carburisation theory, and we think he is right, from our experience of good material. Malleable iron must not be confounded with so-called "steel alloy" made by melting cast and wrought-iron together. Such castings can be forged like wrought-iron, and the process is really a sort of steel-making process, but is not a safe process for important duties. There is evidently no reason why malleable iron should not exhibit a considerable amount of the quality of wrought-iron. That it does not do so in the cases named is the fault of carelessness or neglect.

## ECONOMY OF SUPERHEATED STEAM IN THE TURBINE.

Messrs. C. A. Parsons & Co. draw attention to an error, or misprint, of 100 per cent. in place of 10 per cent. in a recent Note on the steam turbine in reference to the test at Sibley College (Electrical Review, p. 351). These tests showed a gain of about 1 per cent. for 3° superheat, and a gain in capacity of 100 per cent. This should be 12½ per cent. In Prof. Ewing's tests, made several years ago, it was found that with steam superheated 60° the feed water was 28·4 lbs. per electrical unit at full load and 32 lbs. at half load. With saturated steam the steam consumption had previously been 37 lbs. per unit at full and 39 at half load, but certain alterations had been made in the blades and in the air pump, and so these special results were not comparable. The steam consumption had been reduced 27 per cent., and much of this was considered to be due to the superheating.

Undoubtedly there is much less friction with superheated steam than with saturated steam, for the latter is more or less charged with floating particles, which cannot flow of their own energy, and require to be driven through the maze of blades by the energy of the steam, which is so much reduced in consequence.

In a set of trials with steam superheated by the waste gases, the steam of 103 lbs. pressure had a temperature of 398°, and 102 electrical units were generated by each 28·4 lbs. of steam; with 101 lbs. pressure, and a temperature of 465°, the smaller load of 78·4 units was met by the consumption of 27·7 lbs. of steam.

The principal advantage gained from superheating is obtained in the first few added degrees.

An initial temperature of 443° was found practically to stop any condensation due to the performance of work. There was no cylinder condensation of the usual type beyond that due simply to radiation.

Steam of 100 lbs. pressure has a temperature of 338° when saturated, and it appears that the same steam at 433° will be dry at exhaust, because the work done is about equivalent to the disappearance of heat sufficient to take out all superheat from the exhaust. In other words about 100° of superheat will produce the full effect that can be looked for. Prof. Ewing tried to make out an estimate of the steam consumption per I.H.P.-hour, a somewhat thankless task, for it is really of little moment to know the I.H.P. so long as the output of useful energy is known.

In later tests of Prof. Kennedy on an improved turbine, the steam per E.H.P. was only 20·3 lbs., with superheated steam at 97·1 lbs. pressure, and 391° temperature, equivalent to 54·9° of superheat.

It does not appear that anything is to be gained by high degrees of superheat. The turbine can, of course, use highly superheated steam without much difficulty, because it is free from troubles of packing or lubrication, but if the steam is so far heated as to become a perfect gas and to remain so all the way through the machine, any further superheat will probably only reduce the heat economy of the turbine. Further improvements are to be sought in the details of the turbine itself. The turbine tested by Prof. Ewing was, by his estimate, of small mechanical efficiency, the idle work of the turbine being considerable. He estimated the B.H.P. as only 75 per cent. of the I.H.P.

It is a difficult subject to think out, but we should consider that in an inefficient turbine there would be rejected hotter steam than when the turbine was efficient. The steam in passing through the blades must do work either in moving them or in superheating itself. The best result apparently will be marked by the production of the coldest exhaust, and the improvement of the turbine will come in the better form of its blades.

The turbine ought, of course, to take the lead of all other engines, because it allows the steam to move quickly, and in this sense fits in with the molecular theory of gases. Further, there is no cylinder condensation; the turbine is at every point at the temperature of the steam flowing past that particular point. It thereby avoids the worst feature of the piston engine, and should be able to afford a good deal of mechanical loss when its thermal losses are so much less. It is particularly to be desired that the mechanical efficiency should, however, be improved, because if ever it is to be thoroughly successful on the very varying loads of traction work, it will be most desirable to reduce the no-load losses, and it appears to us of immense importance in this respect to run a turbine with the maximum vacuum that can possibly be attained. The no-load loss of a turbine is due largely to the reverse action of the blades and guides. When run light, these blades are churning up air, or *something*. In a perfect vacuum they would be churning up *nothing*, and nothing could not absorb energy. We feel persuaded that the economy of the condensing turbine is to be accounted for on this basis. In fact, the steam turbine is a form of pneumatic brake when run in air. It could act as a blower in some degree, and for this reason a vacuum has a double economy.

## THE ETHICS OF INSULATING MATERIALS.

By J. WRIGHT.

It is not my intention here to discourse upon insulating materials in general, but rather to confine my remarks to a consideration of those substances, chief amongst which are india-rubber and gutta-percha, so largely employed for the insulation of electric cables and wires.

The growing scarcity of the above-mentioned commodities recently led to a short general article in a contemporary from the pen of Mr. Terry, an authority of note on the subject, in which the writer comments upon the various substitutes for rubber and gutta-percha which have been introduced to a greater or less extent during the past few years.

It is not by any means so easy a task as would appear at first sight to obtain a *satisfactory* substitute for rubber and gutta-percha in the insulation of cables. It must be remembered that flexibility, combined with mechanical strength, and resistance to the passage of electric currents of varying tension, disruptive or otherwise, to say nothing of absence of porosity and durability under extremely variable climatic conditions, are but few of the many essential properties which must be possessed in the requisite degree by the substitute. India-rubber, or caoutchouc, as we all know, is a gum obtained from the sap found in the middle layers of the bark of certain trees indigenous to South America, Africa, and the East Indies. It exudes on an incision being made in the bark for the purpose, and is collected by the natives of the locality in various ways. The main object aimed at, however, whatever be the manner in which it is undertaken, is to procure the coagulation of the rubber, by exposing it in thin layers to the smoke of a wood fire fed with a species of nut also indigenous to the locality, and collected for the purpose.

If this drying be not properly effected, the rubber retains a certain compound which acts as a form of solvent and destroys it This destructive agent is always present in a greater or lesser degree, and shows its presence in rubber which has been exposed to the atmosphere for a lengthened period, by converting it into a treacly mass contained by an outer oxidised crust which is extremely brittle.

liked, compare their differences in this manner.

of manganese, and that with large pieces "many days" are required. He differs from Stanford, who says the material



The best, or Para rubber, when freshly procured, is extremely elastic, and has a generous modicum of "life," but, unfortunately, it is impossible to employ it in this condition for insulating purposes, as the impurities which all samples contain necessitate a somewhat severe course of washing and mastication in powerful machines specially designed for the purpose, which treatment decreases its vitality in a marked degree, but, at the same time, renders it, in the form of sheet or strip, of such consistency as to be suitable for applying to the cable.

Pure Para is too expensive to employ alone as an efficient insulating coat, and it is, therefore, applied as a single thin layer, supplemented by a layer or layers of compound rubber which consist of an admixture of pure rubber with certain other ingredients, such as French chalk, sulphur, naphtha (as a solvent), &c., with which, by a due series of apportioning the quality and nature of the resultant rubber compound is *toned*, so to speak, to the pitch required in practice. The resultant rubber, as may be expected, is in the form of a workable mass, not unlike thick putty in the majority of cases, and in this state is applied to the cable or wire in the form of strips.

Now, there are two methods of applying rubber strip to a cable. One, the slower and more expensive method, is by lapping it spirally, two adjacent layers being lapped in opposite directions in order to absorb the joint and render the coating homogeneous. The other method, and the one more generally adopted, is by longitudinal compression. Two strips of rubber are applied to the cable, one above and the other below, and are compressed together at the sides in the form of a seam, by their passage with the cable between a pair of hard steel rolls revolving in contact, and semi-circularly grooved to the finished diameter of the covered cable. The seam thus made is an efficient one, and depends on a peculiar property possessed by rubber to a marked degree, viz., cohesion. If two freshly-cut rubber surfaces be brought into immediate contact, they will cohere and form as homogeneous a mass as the uncut remainder.

Mr. Terry in his article especially refers to the seam in rubber-covered cables, and, I think, rather inclines to regard it as a weak point, but if proper precautions be taken for the exclusion of dirt and moisture, and the covering rolls be accurately turned so as to form a complete circle, there is no danger of weakness.

The subsequent process consists in spirally lapping the cable with a strong canvas tape to resist expansion and its subsequent vulcanisation by exposure to steam pressure at a stated temperature for a certain period. This latter process imparts elasticity and durability to the compound by a combination of sulphur, which is one of the ingredients.

By the judicious apportioning of the ingredients in the rubber compound, and by varying the thickness of the primary coating of pure rubber, the insulation resistance per mile of the finished cable is controlled, and in this manner any result from a few megohms to several thousand may be obtained. The subsequent results are, of course, slightly variable, *i.e.*, they do not resolve themselves into round figures, but an approximation to the required result is easily obtained by experiment. It is also possible to vary the subsequent insulation resistance by the degree of vulcanisation, for the longer a rubber compound is vulcanised up to a certain point, the higher will be its *immediate* insulation resistance. Such treatment, however, beyond the recognised time limit is extremely injurious, as it shortens the "life" of the cable by artificially ageing it; it is a trick resorted to nevertheless by unscrupulous manufacturers to bring their cables up to the specified insulation.

In the earlier days of rubber-insulated cables it was a recognised thing for engineers and others to specify high insulation resistances, and insist on having them, a custom which has, however, led to an investment in wisdom at the expense of the purchaser. With rubber, as with gutta-percha, it is not "initial megohms per mile" which are required so much as durability, low electrostatic capacity, and resistance to disruptive discharge.

I have as yet touched but lightly upon the vulcanisation process which is based upon one of the most important properties of rubber, viz., that of combining chemically with sulphur when under steam pressure at temperatures varying from 250° to 350° F. The action is purely a chemical one, and the rubber, after the process, assumes an elasticity and durability which it did not possess in its raw mixed condition; moreover, the longitudinal seam due to manufacture, is rendered homogeneous by it, and is, in fact, difficult to localise after vulcanisation. It is important to blend with the other ingredients just sufficient sulphur, and no more, than the rubber will take up, as, otherwise, a certain quantity of sulphur will be left free, and will, by its presence, tend to corrode the copper conductor. For this reason the latter is tinned, and in many cases what is known as a "separator" or layer of rubber with little or no sulphur in its constitution is introduced between the primary layer of pure, and the outer one of compound rubber, with the object of absorbing any excess of sulphur not taken up by the latter.

With a good quality, properly vulcanised, rubber-covered cable or wire one can do almost anything, short of wilfully damaging the rubber coat. It will stand bending round its own diameter, and, indeed, very severe handling, before deleterious effects will be observed.

Gutta-percha, also an expensive material for insulating purposes, is not suitable for electric light and power work, where an appreciable rise of temperature in the metallic conductors themselves is at times unavoidable, owing to its susceptibility to variations of temperature. It is, however, admirably adapted for submarine telegraph cables, and also for telegraph and telephone wires laid underground. When new, it has a very light tint, but ages rapidly with exposure to air, darkening in colour, owing to the formation of a crust of oxide on its outer surface, which becomes very brittle. The best conditions for its maintenance are to place it under water having a fairly even temperature of from 40° to 80° F. This prevents oxidation, and it will last under these conditions for years.

For underground work it is usually covered with a strong spiral canvas tape saturated with Stockholm tar, from which, however, the natural acids have previously been extracted. This latter is an important point. Such a covering has a similar preservative effect to the foregoing immersion in water, and it prevents ingress of air, and, in a moist atmosphere, at a fairly even temperature, answers very well.

The well-known Callender cables are insulated with a substance known as "bitite," which consists essentially of purified vulcanised bitumen. They are very suitable for low pressure town mains and feeders where they are not likely to be disturbed, and, for such purpose, are usually laid in troughs filled up solid with a bituminous compound. For general work, however, they will not stand the manipulation that rubber insulated cables are capable of withstanding.

Fibre cables, another substitute for rubber, are certainly cheaper, but they have many disadvantages, which, to a certain extent, annul any advantages due to a low prime cost. They consist mainly of a fibrous material, such as hemp, loosely wrapped round the conductor, and impregnated with suitable insulating compounds, such as bitumen, &c., and subsequently sheathed with lead to exclude moisture. Their disadvantages are numerous; in the first instance, fibrous materials are hygroscopic, and require to be well heated to expel any moisture which they may contain before being lead-sheathed. This heating tends to destroy the fibre. Then, again, air, although a splendid insulator when in a dry state, is unable to withstand disruptive discharges of electricity, and it is practically impossible to manufacture a fibre cable and guarantee the insulating material absolutely free from air, as the latter is readily retained in the form of minute bubbles, which, when the cable is subjected to a high E.M.F., speedily assert their existence by the breaking down of the insulation at that point. Finally, these cables absolutely depend for their insulating qualities on the total exclusion of moisture, and a pinhole in the lead sheathing, although not discernible under the initial tests, means the subsequent development of a fault. Pure lead also, if placed directly in the ground, is very subject to corrosion, although a slight alloy of tin decreases the risk in this respect.

To pass on to paper insulation. As far as telephone work is concerned, paper has evidently come to stay. As an insulating material it is light, cheap in prime cost, and—most important point of all—its specific inductive capacity is extremely low compared with other materials, all of which

his estimate, of small mechanical efficiency, the idle work of the turbine being considerable. He estimated the B.H.P. as only 75 per cent. of the I.H.P.

which has been exposed to the atmosphere for a long period, by converting it into a treacly mass contained by an outer oxidised crust which is extremely brittle.



render it an admirable insulator for underground multiple wire telephone cables. Such cables have been largely adopted by the National Telephone Company, the paper being packed quite loosely around the wires in the lead sheathing, and, in conjunction with their system of passing a continuous current of dry air through the containing sheath, have proved highly satisfactory.

For electric light and power, paper-insulated cables, as manufactured by the British Insulated Wire Company, of Prescot, for instance, are subject to the same disadvantages as fibre cables, but withal, are of comparatively low prime cost and are eminently suitable for low pressure mains and feeders, as well as with a greater thickness of dielectric for high pressures.

Summing up the various materials in vogue for cable insulation to-day, what is urgently required is a substance which, while possessing the durability, elasticity and imperviousness of rubber, shall be cheap, and yield good results electrically, *i.e.*, it must possess a low specific inductive capacity, and a high specific resistance, under all ordinary conditions, and above all, be capable of easy application to the wire or cable which it is intended to insulate.

Such a substance is not at present on the market, but a fortune awaits the lucky individual who discovers and patents such a compound.

## A CRITICISM OF THE BRITISH ASSOCIATION.

[COMMUNICATED.]

In considering the practical value of the British Association, the writer is concerned with its aspects as regards electrical work rather than with the general achievements in science. No one could fairly dispute the fact that the history of the electrical industry has been at some periods intimately associated with the B.A., but this in some measure arises from the fact that the brilliant theorists, whose work formed the foundation of practical electricity, were in a sense officially connected with the Association. Under these circumstances, it was natural that the annual meetings should have been chosen for the publication of new achievements, and in this way much of the early work in submarine cables, the dynamo, and the incandescent lamp was brought to light. Even for some years, practice, such as it was, and theory were not divided to any marked degree, and while the professed theorists held a monopoly of the practice, it was obvious that important papers would be contributed, which evoked valuable discussions. Moreover, in those days the practicists were not averse to a tilt with the professors, and hence one occasionally witnessed some brilliant, if heated, debates on topics that have been, so far as controversial matters are concerned, relegated to the shelves. It would be difficult to over-rate the value of the classic discussion on lightning and lightning conductors at the Bath meeting, and one could not easily forget the controversy which was long waged round the question of new units and electrical nomenclature. Coming to more recent times, there is the splendid work of Prof. Ewing on magnetism, most of which was first published at annual meetings of the British Association. Though these may, perhaps, not be the most important contributions which members of the British Association have given to electrical science, they rank among their best achievements. In later years, however, the influence of the British Association on electrical subjects has not been very considerable; it is true that papers are occasionally presented which are more than ordinarily interesting, but they do little more than cause a ripple on the surface. Nor is it surprising when one considers the conditions which prevail at the present time. Electricity has become of a deeply practical, not to say a commercial, character, and the persons associated with it have little sympathy with a pseudo-scientific gathering like the British Association. Besides, with the growth of the electrical industry the importance of the Institution of Electrical Engineers has increased, and it is obvious that if an electrical man has something original to say, he prefers to do so before an audience which, from its training and knowledge, would have a better appreciation of his remarks than the mixed gatherings that usually assemble in a section room of the B.A. It is not too much to say, therefore, that the value of the British Association from an electrical point of view is of little importance nowadays. Apart from the special circumstances which account for this, one may suppose that if the British Association were to fulfil the original conditions of its mission, it would be impossible for a highly technical community such as the electrical profession, to expect any important contributions upon electrical subjects, but though the present management of the British Association would appear to have entirely forgotten the objects of the Association, it is quite impossible for it to ever regain the position it once held in regard to electrical science. Probably, in the days preceding technical education and cheap printing, the Association may have helped to advance science among the people, but not to any particular extent during the past 15 years. As a matter of fact, the British Association has become something of a close corporation, which might be improved by a little wholesome criticism from outside.

## CABLE SPECIFICATIONS.

[COMMUNICATED.]

The principle of combination is being generally applied to the settlement of labour questions on the basis of "might being right," and not very long ago the manufacturers of generating plant combined and took joint action to avoid needless complexity in the detailed specification of machinery. In conjunction with the Municipal Electrical Association, the Electric Plant Manufacturers' Association prepared some draft clauses with a view of their being adopted by consultants and designing engineers in the general conditions attached to tender forms for electrical plant.

This action has been followed by "The Cable Makers' Association," whose honorary secretary, Mr. A. H. Howard, has just issued, apparently to members, associate members and associates of the Institution of Electrical Engineers, who are connected with or engaged in the design and management of central stations, a table of electric supply mains, and draft terms and conditions for tenders, which it is believed will, if adopted, "act equally for the benefit of the purchaser and the manufacturer," and they, it is suggested, might be adopted in specifications being prepared. It is, perhaps, not ultra-criticism to say that such documents, emanating from a purely trade combination and published without any opportunity being given to those affected, of proposing modifications, are hardly likely to act *equally* in the interests of two parties to a contract, whose views on many points must be divergent if not in direct opposition.

We cannot overlook the unequal, and, in some cases, unfair requirements to which cable-makers are at the present time called upon to submit, and Mr. Raworth's old notion of educating the consulting engineer would, if now put into practice, tend to eradicate some of the evils. Technically, specifications are usually well considered, but in some of the legal obligations the terms are—to use the only words applicable—harsh and inequitable. The consultant should remember that, after all, the contractor has rights and privileges as well as his client or clients, and that undue severity must in the long run create and organise a bold-fronted and powerful opposition. On the other hand, the word "contractor" includes so many persons, firms, and companies, and the views of such of their officials are so variable and frequently take such a lenient aspect when it comes to dealing with the weaknesses or troubles with the plant or material supplied, that engineers are only doing their duty by their employers in safeguarding them against evasion of his responsibilities by the contractor.

Standardisation is a good thing, but there is a suspicion in some engineers' minds that what contractors mean when

from 250° to 350° F. The action is purely a chemical one, important point of all—its specific inductive capacity is extremely low compared with other materials, all of which



they use this term is a standardisation entirely in favour of the contractor. For example, the suggested basis for tenders now being considered states that "the engineer's decision shall *not* be final," but that there shall be an arbitration clause. We have no hesitation in saying that this general statement cannot be supported on grounds of equity. In some matters, such as the quality of goods supplied, the engineer's decision must be final if endless disputes are to be avoided. The real safeguard of the contractor is that the engineer is amenable to public opinion, and particularly is he subject to the reputation he sustains with his board of directors or electricity committee. An appeal from his decision always is heard by the committee or board, but the intrinsic position of the engineer is weaker than that of the contractor, inasmuch as the engineer is almost universally a servant, and the contractor is a principal. Few engineers have abused their positions: they are, as a body, well aware that it will not pay them to be unreasonable, and we therefore fail to see why one or two black sheep, with obstinate dispositions, should be allowed to interfere with the general practice of the profession.

Another important matter is the issue of certificates by the engineer. It is now required that these shall be granted within 14 days of presentation of account, and that payment be made within one month from date of certificate. These conditions are perhaps reasonable enough, as also is the stipulation that payment shall be made on not less favourable terms than 80 per cent. on monthly certificates, followed by 10 per cent. on completion or putting to work, and the remaining 10 per cent. 12 months after completion. It is expressly stated in these draft conditions that "the completion or putting to work is not to be dependent on any other contractor." We presume the payment is not to be deferred on this account; engineers would only be too pleased to learn of some method whereby such delays may be entirely avoided. At present they are only too common.

Of course the question of penalty for default in starting or completing works is ignored, but such penalty clauses are only corollaries to one now suggested, wherein the purchaser is required to pay to the contractor all reasonable expenses arising from suspension of the works by the engineer, unless such suspension be due to any fault on the part of the contractor. How such "expenses" are to be ascertained is not stated or even indicated, and a very fruitful source of friction, and even legal squabbles is introduced by this clause.

With some of the clauses one can agree, as they are only fair dealing, and give the contractor what is even now given by many impartial engineers. Thus specifications are to be supplied in duplicate. This is quite reasonable, and we know of engineers who willingly grant even three printed copies to tendering firms. Then in the case of a yearly contract for cable, unless the contractor has some knowledge of the quantity of material he will probably be called upon to supply, it is extremely difficult to arrange equitable and fair prices, which will be on all fours with competitors. We see no reason, therefore, to deny the right—now sought—of contractors to be made acquainted with the approximate quantities upon which he will have to tender, and that he should be at liberty to refuse to supply more than 25 per cent. greater quantity or less than 25 per cent. smaller quantity unless special arrangements as to price are made and accepted. When tests are taken on site, it is also fair that the current required for this purpose should be supplied to the contractor without charge at the pressure of the ordinary supply. It is, however, questionable (although the reason for the suggestion is obvious), whether, when cables are merely supplied, the drum containing them should only be allowed for in full when returned within three months and carriage paid. Carriage of returned empties should always be paid for by the contractor, and the empties removed by him or to his instructions by his agents, otherwise endless trouble arises from the checking and payment of a host of small accounts.

We believe that one of the clauses to which the strongest exception will be taken, and opposition offered, is that stating that nothing shall be required from the contractor unless it be *detailed* in the specification. It is quite out of the question to do this in everyday practice. Theoretically it may be done, but no engineer or engineer's staff can arrange for every single stick of solder, screw, clamp, &c., &c., to be *detailed* and mentioned in the specification. What the contractor undertakes to supply is a complete article to do certain work, and it is a retrograde step to make the specification a bill of quantities for articles often yet to be designed in detail by the contractors or tenderers. All the tone of the Institution discussions has been the other way, and we certainly think this clause will be found quite unworkable.

A knotty point is the guarantee. The difficulty, when a fault has come on and been burnt out, is to say whether it was due to defective materials and workmanship or not. It is admitted that any fault due to defective material or workmanship occurring within 12 months of laying shall be made good, but "where there is no proof that the defect was caused by bad material or workmanship," a charge is to be made on and settled by the purchaser. Proof in such a case can only be obtained by inductive reasoning, and must rest on logical grounds alone, since the fault destroys the evidence of its cause.

An attempt is also made to separate "guarantee" from "maintenance," exactly how this is to be effected not being stated. The guarantee and maintenance should cover 12 months, and all trouble, which on good grounds can be shown to be probably due to default of the contractor, should be rectified. Then when the final payment has been made, if further maintenance be required, it must be a matter of mutual arrangement and agreement between the parties interested.

The table of conductors shows the sizes proposed to be accepted as standard. No fault can be found with the suggested areas, as it will be a great advantage to have *some* fixed standards to work to, and it is less important exactly what sizes are chosen, than that all over the country these should be the same.

Eleven of the most important wire and cable manufacturers have agreed to the suggested clauses, and it is the intention that they, together with the table of sizes of conductors, should come into force on October 1st prox. That they will be accepted as they stand, we cannot believe, but they will form a good basis upon which, and from which, to work towards a general form of agreement.

## CORRESPONDENCE.

### The Doom of the Contractor.

I am glad to notice that someone has taken up this important question, as quite a number of instances of consulting engineers acting as contractors have recently come under my notice. Surely it is the duty of manufacturers to refuse to quote trade prices to so-called consulting engineers; and I would suggest that manufacturers who are found damaging the trade by encouraging this pernicious habit, should be given a wide berth by contractors when placing their orders.

**Contractor.**

### Guard Wires.

It may interest Mr. Quin and others taking part in this discussion to read the following notes made from observations taken during weekly visits to Liverpool:—Wooden strips were erected on the trolley wires of the first routes taken in hand; very soon these began to work loose, and the clips to cause the wheels to jump, making an objectionable noise; later the strips turned over and broke off.

On later routes one guard wire has been run from pole to pole to protect both track wires. At the present date, I could show any visitor scores of telephone lines crossing the track without any protecting device whatever, some of them heavy lines carrying upwards of 100 wires.

If the guard wires are not enforced, surely the best policy, from the tram engineer's point of view, is to omit them altogether.

Personally, I think a hammock, suspended between the bottom arms of the telephone poles on either side of the track, the best for *heavy lines* in towns, since these wires are

usually on the roof of the buildings, and consequently out of the line of sight of an ordinary observer. For single wire lines the separate street span, with releasing hooks at both ends, would seem to be the simplest solution.

C. B. Nixon.

Manchester, *September 18th*, 1900.

---

**Hot Bearings.**

I have a 250-KW. continuous current, four-pole rope-driven dynamo under my care, which has been running about three months, the bearings of which are giving a great amount of trouble through heating. They are three in number, and of the following dimensions:—22 inches long × 6¼ inches diameter; they are spherically seated and lined with anti-friction metal. Each bearing is lubricated by means of two oil rings and a sight-feed lubricator. Speed of machine 470 revolutions per minute.

The temperature of these bearings is, with difficulty, kept down to the following figures: Commutator end bearing 75° F. above surrounding air, and pulley end 55° F. above air; that of centre bearing usually being midway between these. Temperature of air about 80° F.

The above figures are reached during the first 15 to 30 minutes' run, starting all cold.

Are these temperatures excessive; if so, what is the highest permissible working temperature for bearings of this size, &c. ?

I may say that after a six hours' full load run the greatest rise in temperature above surrounding air of any part of winding of machine did not exceed 27° F.

Temperature.

Sheffield, *September 19th*, 1900.

---

## BUSINESS NOTES.

### Electrical Wares Exported.

| Week ending Sept. 19th, 1899. | | Week ending Sept. 18th, 1900. | |
|---|---|---|---|
| Amsterdam .. .. .. | Value £20 | Adelaide .. .. .. | Value £75 |
| Bombay .. .. .. .. | 298 | Alexandria .. .. .. .. | 170 |
| Boulogne .. .. .. .. | 97 | Amsterdam .. .. .. | 100 |
| Buenos Ayres .. .. .. | 103 | Auckland .. .. .. .. | 161 |
| ,, ,, Teleg. mat. .. | 80 | Bombay .. .. .. .. | 169 |
| Calcutta .. .. .. .. | 368 | Brisbane .. .. .. .. | 20 |
| Canterbury .. .. .. .. | 155 | Buenos Ayres .. .. .. | 367 |
| Cape Town .. .. .. .. | 46 | Calcutta .. .. .. .. | 244 |
| Channel Islands .. .. .. | 330 | Cape Town .. .. .. .. | 638 |
| Chinde. Teleg. gear .. .. | 11 | Colombo .. .. .. .. | 68 |
| Christiania .. .. .. .. | 27 | Copenhagen. Teleg. wire .. | 61 |
| Colombo .. .. .. .. | 152 | Durban .. .. .. .. | 773 |
| Durban .. .. .. .. | 366 | ,, Teleg. apparatus .. | 442 |
| East London .. .. .. | 113 | Emden. Teleg. apparatus .. | 308 |
| Falkland Islands .. .. .. | 10 | Essen. Teleg. mat. .. .. | 60 |
| Flushing .. .. .. .. | 11 | Flushing .. .. .. .. | 28 |
| Hamburg. Teleg. mat. .. | 310 | Gibraltar .. .. .. .. | 20 |
| Korsor. Teleg. cable .. .. | 9,900 | Hamburg. Teleg. mat. .. .. | 200 |
| Lisbon .. .. .. .. | 66 | Hong Kong .. .. .. .. | 102 |
| Montreal .. .. .. .. | 60 | Launceston .. .. .. .. | 85 |
| Ostend .. .. .. .. | 230 | Lyttleton .. .. .. .. | 158 |
| Perth .. .. .. .. | 40 | Malta .. .. .. .. | 32 |
| Port Elizabeth Teleg. mat. .. | 83 | Mauritius .. .. .. .. | 30 |
| Rio Janeiro .. .. .. .. | 212 | Melbourne .. .. .. .. | 1,218 |
| ,, Teleg. mat. .. .. | 87 | ,, Teleg. mat. .. | 994 |
| Rotterdam .. .. .. .. | 85 | Ostend .. .. .. .. | 300 |
| ,, Teleg. wire .. .. | 27 | Rotterdam. Teleg. wire .. | 74 |
| Santos .. .. .. .. | 52 | Shanghai .. .. .. .. | 165 |
| Santiago .. .. .. .. | 85 | Singapore .. .. .. .. | 33 |
| Shanghai .. .. .. .. | 55 | Sydney .. .. .. .. | 675 |
| ,, Old teleg. wire .. | 157 | ,, Teleg. mat. .. .. | 624 |
| Singapore .. .. .. .. | 17 | Trieste .. .. .. .. | 365 |
| Sydney .. .. .. .. | 1,114 | Wellington .. .. .. .. | 2,467 |
| Trieste, Teleg. mat. .. .. | 600 | ,, Teleg. mat. .. .. | 4,180 |
| Yokohama .. .. .. .. | 619 | Yokohama .. .. .. .. | 408 |
| | | ,, Teleg. cable .. | 13,284 |
| Total .. | £15,896 | Total .. | £29,018 |

### Foreign Goods Transhipped.

| | | | |
|---|---|---|---|
| New York. Elec. carriages. | Value £250 | Perth. Teleg. wire .. | Value £215 |
| Singapore. Elec. light mat. .. | 8 | | |
| Total .. | £258 | | |

**Bankruptcy Proceedings.**—Notice is given of the release of trustee (Mr. A. H. Wildy, official receiver), in *re* E. B. Pym, electrical engineer, Scarborough. Mr. Wildy is also released from the trusteeship, in *re* E. Max. Winter, electrical engineer, of Amberley House, Norfolk Street, London.

Notice is published of an intended dividend in the case of A. G. Inrig (Globe Electrical Company), electrical engineer, Victoria Park, London. October 2nd is the last day for receiving proofs. Mr. E. H. Hawkins, 3, Barbican, E.C., is the trustee.

**Liquidations and Dissolutions.**—The Roller Bearings Company, Limited, is winding up voluntarily, with Mr. F. L. Fisher, Portland House, Basinghall Street, E.C., as liquidator.

A meeting of Woodlands Electric Company, Limited, will be held on October 15th, at 10 Berey's Buildings, George Street, Liverpool, to hear an account of the winding up proceedings from Mr. F. J. Armstrong, the liquidator.

**The Birkbeck Institution.**—This Institution, which has now completed 77 years of educational work in the metropolis, commences its new session on Monday, October 1st.

**Boiler Registration and Inspection.**—The Bluebook of evidence given before the Select Committee is out. The Committee was constituted as follows:—

Mr. J. Penn (chairman), Sir William Arrol, Mr. J. W. Crombie, Mr. A. Emmott, Mr. C. Fenwick, Sir Fortescue Flannery, Mr. W. J. Galloway, Mr. W. Hazell, Sir Edward Gourley, Mr. J. Heath, Sir Alfred Hickman, Sir William Houldsworth, Mr. R. McGhee, Col. R. Pilkington, and Mr. C. B. Renshaw. The Committee held 16 sittings and examined 22 witnesses, including three officials of the Board of Trade, six representatives of boiler insurance companies, the secretary of the Mining Association of Great Britain, the consulting secretary of the Boilermakers' and Iron and Steel Shipbuilders' Society, and 11 delegates of the engineering, cotton spinning, agricultural, chemical and other industries.

The Committee point out three ways of securing more frequent inspection by competent persons:—

"1. By the appointment of inspectors under a Government Department, but do not recommend this, as they consider: (*a*) That the responsibility of selecting a competent person should fall upon the owner or user of the boiler; (*b*) That the owner would shelter himself behind the inspector of a Government Department; (*c*) That the inspectors under a Government Department would work upon inelastic lines, and that this would hamper the development of boiler improvement.

"2. By extending the powers of the Court set up under the Boiler Explosions Acts, 1882—1890, to enable the Court to inflict heavy penalties in event of an explosion, if it be shown (*a*) to the satisfaction of the Court that such owner or user failed to have his boiler inpected by a competent person at a reasonable period prior to the explosion; conditions of working, quality of feed water and custom of the locality to be considered by the Court when determining what a reasonable period is; (*b*) that the boiler has been worked since the last inspection at a pressure exceeding that for which the boiler has been certified, or that there has been wilful and culpable negligence in carrying out any recommendations made at the last inspection; also giving the Court power to inflict like penalties on the inspector, if it be shown to the satisfaction of the Court that the inspection was carelessly or insufficiently carried out."

This extension of powers, it is thought, would lead to an extension of inspection, because the responsibility of a boiler user would be brought home to him by the inspection companies and others interested, as well as by reports of penalties incurred by steam users who had come under penalty, &c.

3. The Committee considered "that an extension of the Factory Acts, empowering an inspector to call upon the owner or user of a boiler to produce a certificate or entry showing that he has had his boiler inspected by a competent person within a year, and providing that in cases where the Factory Acts do not apply this authority should be vested in the police, would make the inspection of boilers practically universal."

This last recommendation seems to us to be a good one. The report may be cautious and not marked by genius; but it is a sound, common sense, businesslike report, which will give an immense fillip to that voluntary action that has placed English boilers far ahead of those of all other countries in excellence of manufacture and safety in working. We should be very sorry to see Government control. The Board of Trade we would specially debar. Police inspection, beyond the power to demand the certificate, would be a farce, as it is in New York City and other American cities.

**Catalogues and Lists.**—The British Westinghouse Electric and Manufacturing Company's circular, No. 1,030, describes their O.D. transformers for electric light and power work. This type is stated to embody the improvements which have been brought about as the result of 15 years' practical experience in the manufacture of the Westinghouse transformers. Diagrams of connections and illustrations of parts are shown.

Messrs. Krupka & Jacoby, of Watling Street, E.C., send us a list of Siemens & Halske's incandescent lamps for high and low voltages, and also a card of Lessing's dry battery.

Messrs. Johnson & Phillips have issued a new catalogue of their electric light and power wires and cables, in which they give within the compass of 20 pages a mass of tabulated and other data regarding them. A double-page table gives details of pure copper conductors arranged in order of carrying capacity, and other tables particularise various classes of taped, braided, lead-covered, and other conductors, giving sizes, weights, and prices per yard and per mile. Owing to a slight fall in the market prices of raw materials, Messrs. Johnson & Phillips are allowing an additional 5 per cent. discount off vulcanised rubber cables listed in their February, 1900, catalogue. The firm's new cable factory for the manufacture of lead-covered and armoured cables for town lighting is now in working order, and they are at the moment executing a contract for the Manchester Corporation.

Those who are interested in what is being done by Messrs. Brown, Boveri & Co. at Baden—and we suppose there are very few English electrical men who are not so interested just now—will be able to obtain an idea of the important work they are turning out,



**The Electrical Company.**—An important development

of producing 200 gallons of good drinking water per day, and weighing only 25 lbs. Several of these have been in use with satisfactory

from a brochure which they have lately issued reporting upon some of the more consequential installations which have been carried out by them during the past few years. It contains over a dozen full-page photographic reproductions showing the Frankfort-on-Main single-phase alternating (3,000 volts) station, 13 500-H.P. single-phase alternators at St. Petersburg, two 1,000-H.P. and 1,600-H.P., three-phase generators and motors at Prochoroff spinning mills, seven 2,200-H.P. 15,000 volts three-phase generators for the Paderno-Milan power transmission plant, three-phase (3,600 volts) machines at the Porta Volta central station, in Milan, three-phase (4,000 volts) power-house on the Kander, two-phase alternating (5,000 volts) machines at the central station at Chevres, near Geneva, two-phase alternating (5,500 volts) plant at Olten-Aarburg electricity supply works, two-phase alternating (3,000 volts) machines at the Rathausen electricity supply works, 1,500-H.P. single-phase alternating (4,000 volts) turbo-unit at the Elberfeld Corporation electricity works. We can only mention these few of the host of such plants which are catalogued in this most interesting publication, but they serve to indicate what is now doing on the Continent, and perhaps may bring home to us once more the direction in which development must take place in English electrical engineering.

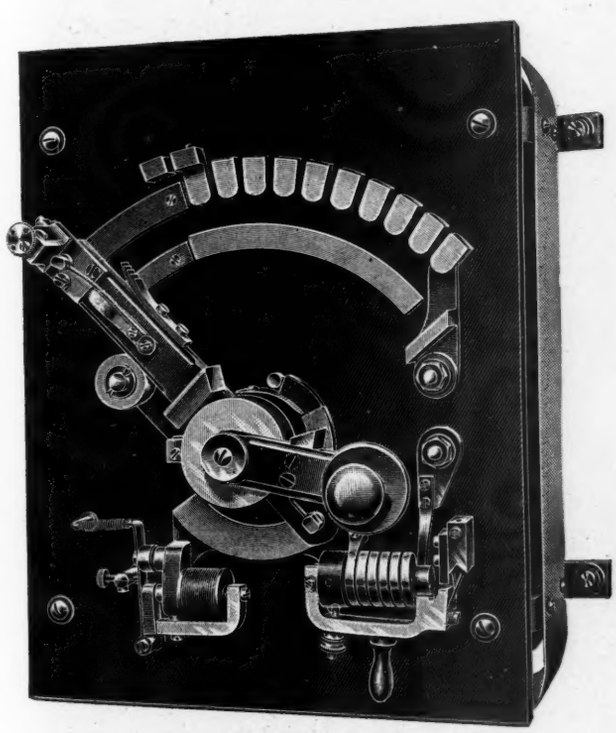
The British Thomson-Houston Company's pamphlet, No. 72, reprints from the *Iron and Coal Trades' Review*, the translation of an article by Mr. Müller, of Essen, on the subject of "Electrical Winding and Haulage Machinery." The article describes what is being done in several collieries for which the B.T.H. Co., or its Continental house, has supplied electrical plant.

Messrs. W. Wilson Cobbett, Limited, of Southwark Street, S.E., and Lanark, send us a small list of the "Scandinavia" M.C.M. belting and belt stretcher.

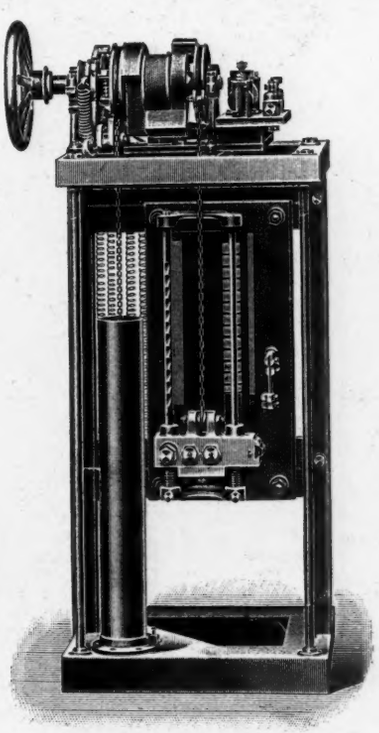
Messrs. Maguire & Baucus, of Warwick Court, W.C., send us a list of their electric railway supplies, including electric trucks, the "protected" rail bond, "phono-electric" wire, vitrified tile conduits, also flexible steel "armorite" conduit for interior construction.

**Starting Switches.**—A new type of motor-starting switch is being put on the market by the Electrical Transmission Company, Limited, Hammersmith, under the patents of Mr. W. F. Jones. The essentially novel feature of the switch is that the handle is not directly attached to the switch arm, but is only held to it by electro-magnetic means when the conditions are suitable. The switch arm and handle lever are of iron, and have pole-pieces attached to them, extending across the face of a coil, mounted so as to surround the iron spindle of the switch, and together they constitute an electro-magnetic clutch. The switch also has a temporary contact (shown just above the clutch coil in the illustration), a "non-sparking" arrangement (shown at the bottom left in the illustration), and a maximum cut-out and hand switching-off handle (shown at the bottom right in the illustration). The illustration shows the "B" type switch in the "off" position, and the action of switching-on is as follows:—The handle is brought towards the switch arm, so as to bring the pole-pieces together, and in doing so makes the circuit at the temporary contact to energise the clutch coil and excite the motor magnets, as the clutch coil is in series with the motor field magnet coils. It is then necessary to pause for a short period, depending on the size of the motor, until the current in the field magnets has risen to about the proper amount, as otherwise the clutch will not be sufficiently powerful for the switch handle to draw the switch arm against the spring which has brought it to the "off" position. The switch arm may then be drawn slowly from contact to contact until the full "on" position is reached, when the switch handle is held by a spring detent. The gradual rise of the current in the field magnets of a motor, especially those of large size, can be easily noted by placing an ammeter in the circuit, and where it is not taken into account serious damage to switch contacts and sparking at the motor brushes results, through the only partial excitation of the magnets and consequent rush of current through the armature. Should the operator switch on too quickly the maximum cut-out acts, short-circuiting the clutch coil, and releasing the switch arm from the handle, when it springs back to the "off" position, inserting the resistances as it does so. The object of the "non-sparking" arrangement is to temporarily close the circuit whilst the switch arm is travelling to the first contact of the switch when it is cut out of circuit. Open type switches are provided in all cases with wire guards, so that the action of the apparatus cannot be interfered with, and the maximum cut-out handles are arranged so that they cannot be held down. The circuit is broken on carbon contacts, and all contact parts are renewable.

In general principle the "A" type switch is the same as the "B" type, previously described, but the arrangement of the parts is different, as the contacts are arranged vertically in alignment, and the clutch and other apparatus are fixed at the top of the pedestal. The great advantage of this switch over the "B" type is that it takes the starting-up entirely out of the operator's control, and switches on at the speed for which it is adjusted. The operator is unable to interfere with the process of switching on, although at any time he can instantly switch off. It also avoids a fault which has prevented the satisfactory continuous working of other slow moving switches in that the switch arm stops when fully on each contact and proceeds with a "quick-make" to the next, when cutting out the resistance in switching on. This prevents the fusing and sparking which take place with a slow moving switch-arm, owing to the great current density when passing from one contact to the next, as practically the whole current passes through the contact in advance, and with a slow moving switch the actual contact area, for a considerable time, may amount to little over a line or a point. The above results are arrived at as follows:—When starting-up, the operator winds up a heavy weight in a dash-pot by means of a spring bolt; when fully wound up, the hand-wheel shears out of engagement with the weight by compressing the spring bolt, and is locked to prevent further forward movement. The weight then descends in the dash-pot, drawing the switch-arm over the contacts, and the "step-by-step" motion is secured by a spring detent which acts at each contact. The act of moving the handwheel backwards to switch off, causes the short-circuiting of the clutch and release of the switch-arm. The whole of the mechanism is enclosed in a strong weather-proof case, nothing appearing outside but the handwheel. With this type of switch it is practically impossible for the most clumsy operator to damage either the motor or the starter.



"B" Type Switch.



"A" Type (on Special Frame); Case Opened.



**Zschocke's Patent Water Cooling Towers.**—We under-

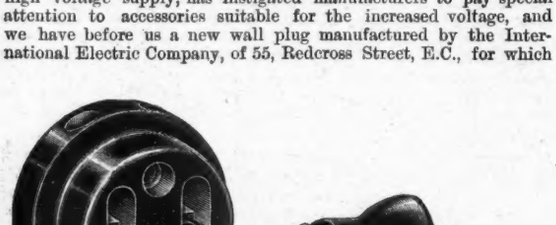
water from the River Bulwick as a motive power, but owing to doubts as to the sufficiency of the water-power the scheme dropped.

**The Electrical Company.**—An important development has been recently carried out by the Electrical Company in order to cope with extending business. A new building has been put up and arranged for a fittings department at 162, Shaftesbury Avenue, not far from the headquarters of the company in Charing Cross Road. In the showrooms a most comprehensive display is made of ceiling, wall, and table fittings, as well as bronzes, pedestals, and other artistic accessories. A separate department is allotted to each class of fitting, and a choice can be made without delay. The arrangement of the premises enables the company to demonstrate to the customer how to have his house or his business premises fitted up in the most appropriate and effective style. Most of the items shown are of quite recent design, and, of course, novelties are being continually added. The show is well worth inspection by the trade, who will find that special facilities are given both for the introduction of their clients and also for the expeditious completion of installations.

**For Sale.**—On Tuesday, October 9th, Messrs. Branch and Leete will offer for sale certain land, premises, works, &c., lately occupied by Messrs. C. & A. Musker, Limited, hydraulic and electrical engineers, at Dundas Street, Bootle, Messrs. Musker having removed to other premises.

**Germany.**—Electric boring machines on the Siemens and Halske system have lately been introduced in the Court Colliery in Prussia. The borers are connected to the electric motor by a flexible driving shaft, and are stated to require only 1 H.P.

**H. V. Wall Plug.**—The change from low voltage to high voltage supply, has instigated manufacturers to pay special attention to accessories suitable for the increased voltage, and we have before us a new wall plug manufactured by the International Electric Company, of 55, Redcross Street, E.C., for which



they claim that, as far as insulation is concerned, it will answer all (even the most stringent) requirements of central station engineers. They further assert that arcing or short-circuiting is an impossibility, as all the current-carrying parts are deeply embedded in china, and surrounded by the same material, no metal parts being at the back of the china base, and the plug itself is provided with their patent porcelain cord grip, so that in that respect the article seems to fulfil all that is claimed by the manufacturers.

**A Minor Use for Electricity.**—We read that during a pigeon-shooting contest at Wharncliffe last week, a man was fatally shot while engaged pulling the rope connected with the trap from which the birds were liberated. A way to avoid the occurrence of such mishaps in future would be to operate the trap by means of electrical apparatus.

**Paris Exhibition.**—The British Aluminium Company, Limited, of Victoria Street, S.W., have been awarded a Gold Medal for their aluminium. The company has two stands at the Exhibition, one of which, on the ground floor, is confined principally to raw material, and the other on the first floor to manufactured goods. The respective managers at their four factories, *i.e.*, Foyers, Larne, Greenock, and Milton, have also been awarded a silver medal each as collaborators in making the stands a success. Judging by the very fine display of aluminium articles brought together at the two stands in Group XI., Class 63 and 64 at the above exhibition, it is evident that aluminium is being used more and more extensively every day, which, indeed, is not surprising when it is borne in mind that the metal is now, bulk for bulk, cheaper than brass, copper, tin, &c., and there is no more difficulty in working this metal than any other metal. Aluminium lends itself admirably for *repoussé* and all kinds of hand-hammered work, samples of which can be seen in the excellent collection of Indian work brought together. Messrs. Bodill, Parker & Co., Limited, Messrs. Vaughton Brothers, Messrs. Hudson, Edmunds and Co., Messrs. Evered & Co., Limited (door furniture), Messrs. Camelinat & Co., and other firms co-operated in helping to make the exhibit a success, and some of these firms show cases containing articles all made in aluminium. Messrs. Thomas Bolton & Sons, of Oakamoor, Staffs., tube and wire drawers, sent a fine collection of tubes and wire in aluminium, and there is also shown a large coil made by Messrs. Isaac Storey & Sons (out of tubes supplied by the above-named firm), fixed to a large still, of which the British Aluminium Company, Limited, have already supplied several for use in the making of acetic acid, aluminium having been found most suitable for this purpose. Messrs. Holmes & Co., carriage builders, of Derby, also assisted in sending a dogcart fitted with aluminium panels. Another very interesting article on show is a portable water sterilizer made in aluminium by Mr. H. W. Neild, of Blackheath, which was specially designed for use in connection with the present operations in South Africa, the article being capable of producing 200 gallons of good drinking water per day, and weighing only 25 lbs. Several of these have been in use with satisfactory results. Another considerable use for aluminium in the shape of wire, strip bars, &c., has lately come to the front in connection with electricity. Although its resistance is about 60 per cent. greater than that of copper having the same cross-sectional area, still this is claimed to be more than made up by the difference in weight of the two metals, so that for equal conductances the cost of aluminium conductors at to-day's prices is less than that of copper ones. Further, for equal conductances only about half the weight of aluminium is required. The use of aluminium would also involve a great saving in the cost of transport, and economy in the number of poles and supports in the case of aerial lines. It may be mentioned that several large firms in this country have given their attention to this question, and several large quantities of the wire have been supplied and put to practical use, with, we are assured, satisfactory results.

Messrs. Sherard Cowper-Coles & Co., Ltd., have been awarded the Silver Medal at the Paris Exhibition for their exhibit in connection with the development of the electro-metallurgy.

**South Africa.**—The *British and South African Export Gazette* says that the exports of British electrical goods to South Africa during the five weeks ending August 21st amounted in value to £9,995, an increase of £3,184 over the amount for the corresponding period of 1899. The Town Council of Ladysmith, Natal, contemplate introducing a system of town lighting either by electricity, acetylene or gas. Tenders will shortly be called for. An expenditure of £50,000 is about to be made for the installation of additional power plant for the Capetown electric tramways.

**Technical Classes.**—The Michaelmas term of the City of London College magnetism and electricity, &c., classes commences on October 1st.

The new session at the South-Western Polytechnic, Chelsea, commences on September 24th. Particulars will be found among our "Educational" advertisements this week.

**Trade Announcements.**—The British Thomson-Houston Company, Limited, of 83, Cannon Street, E.C., have recently opened a branch office in Manchester, in the Trevelyan Buildings, Corporation Street, for local inquiries.

Messrs. John Worthington & Co., electrical and mechanical engineers, of Hanley, are opening a London office and showrooms at 15, Brownlow Street, Holborn, W.

The Naval Electric Company, with offices at 95, Liberty Street, New York City, has been organised to succeed the B. & H. Electric Company, of Dannsville, N.Y., and New Haven, Conn. Among other things, the company works the invention of Messrs. Hall and Burdick of an arc light for use under water, and known as the Yale submarine arc lamp. Another speciality that is being placed on the market by the company is known as the B. & H. rapid fire electric saluting yacht cannon. These are made after the style of the Hotchkiss gun. The guns have a new electric firing attachment for firing from any part of a yacht.

Messrs. Everett, Edgcumbe & Co., of 22, Charterhouse Square, E.C., have taken over the instrument-making business of the Edwards Electrical Company, of Bow, E., which included those of Messrs. Nalder & Harrison, Ltd., and Messrs. Swinburne & Co., Ltd. Messrs. Everett propose not only to continue the manufacture of the instruments for which those firms were known, bringing each completely up to date, but they also have in hand several specialities in the way of central station instruments. We have received from them a few advance sheets from the full list which is now preparing. These lists contain particulars and some first class illustrations of alternating and direct current recording voltmeters and ammeters, the Swinburne non-inductive wattmeters, &c.

Messrs. Prestwich & Burt, electrical engineers, of 65, High Street, Kingston-on-Thames, have dissolved partnership, and the plant and machinery of the firm will be sold by auction on their premises on Wednesday, September 26th.

**Worthington Pumps at the Paris Exhibition.**—A very finely illustrated souvenir of the Exhibition has been brought out by the Worthington Pumping Engine Company. It shows the location of the various Worthington pumps exhibited by the allied Worthington Companies, scattered throughout the French, American, Hungarian, and English sections. In the French section, the entire water supply of the Exposition is furnished by four Worthington triple-expansion high duty pumping engines located in the Worthington Pavilion, Quai d'Orsay. These engines have a capacity of 40,000,000 imperial gallons per day; the water delivered is pumped to the basin of the Château d'Eau on the Champ de Mars, and after use in this fountain passes by underground conduits to the Machinery Hall, whence, after being used for condensation purposes, it is returned to the Seine. In the American section, the Eiffel Tower is equipped exclusively with Worthington pumps, numbering in all 17 machines, among these being five triple-expansion hydraulic pressure pumping engines for elevator service, also independent condensers for use in connection with the above and various small pumps for other purposes. In the Hungarian section, in the Machinery Hall is exhibited a Worthington triple-expansion high duty pumping engine of 300 pump H.P. This engine was built for the waterworks service of the City of Budapest, and is the seventh engine of similar size built during the last five years for the water supply of that city. In the English section, in the Machinery Hall is exhibited a Worthington triple-expansion jet condenser, used to condense the exhaust steam from a 2,500 I.H.P. Willans & Robinson engine. The above comprise only the special exhibits.



**London.**—St. Pancras.—The Vestry has decided to borrow from the County Council the sum of £1,937 for electric committee to carry out the proposed scheme upon the bases recommended. The town clerk was empowered to take all necessary

**Zschocke's Patent Water Cooling Towers.**—We understand that Messrs. Doherty & Donat, engineers and contractors, 40, South King Street, Manchester, are the sole licensees for Great Britain for the above cooling towers, and they intimate that they are prepared to execute contracts for complete condensing and cooling plants. We understand that there are already over 600,000 I.H.P. of these cooling plants, including 35 electric light and power stations, in operation. On the Continent their customers include such firms as Fred. Krupp, Essen, and the Monster Iron-works at Bruckhausen on the Rhine, the latter firm possessing towers for about 18,000 I.H.P., which is stated to be the largest cooling plant in existence.

## ELECTRIC LIGHT AND POWER NOTES.

**Aberavon.**—The Gas Committee of the Town Council has decided to advise the Council to go in for a provisional order for the supply of electricity.

**Ayr.**—Mr. A. J. Fuller, burgh electrical engineer, submitted his annual report to the Town Council last week. It stated that the number of consumers was now 372. The annual output from the works had gone up from 297,420 units to 425,639 units, representing an increase of 43 per cent. A substantial reduction had been made in the cost of production, the rate being 1·80d. per unit, as against 2·03d. With a revenue of £5,244, the department was able to meet working expenses, pay the interest on capital, amounting to £1,530, and have a surplus of £235 towards paying off the annual sinking fund.

**Barrow.**—The Town Council has received reports from Messrs. Kincaid, Waller & Manville with respect to an application to the Local Government Board for leave to borrow £6,690 for electric lighting purposes.

**Bedford.**—The Town Council has resolved to raise the price of electrical energy from 4½d. to 5½d. per unit from March 31st, 1901.

**Birkenhead.**—At the monthly meeting of the Town Council, a motion that the Gas, Water, and Electrical Committee be instructed to report upon the "expediency of reducing the charge for the use of electrical energy to 4d. per unit," was carried after much discussion.

**Bradford.**—At a meeting of the Electricity Committee of the Corporation last Friday, it was announced that the Local Government Board had sanctioned the borrowing of a sum of £50,000 for electricity purposes.

**Camborne.**—The Camborne and Redruth Tramway Company has purchased the provisional order for electricity supply obtained by the Camborne Electricity Company in 1898; the District Council intends to ascertain the terms upon which the company will supply electricity for street lighting.

**Cannock.**—At a special meeting of the District Council last week it was unanimously decided to make an application to the Board of Trade for a provisional order authorising the Council to supply electricity within the district.

**Cardiff.**—At Tuesday's meeting of the Electrical Committee, the chairman, Alderman Carey, in answer to a question from Mr. Good as to the accident on the mains to the mains superintendent and another man, said the committee had desired the town clerk to report to the Board of Trade, and he had no doubt the Board of Trade would hold an inquiry. Speaking under the instructions of the town clerk, he said the latter had advised that the matter should not be discussed until the Board of Trade had taken action. He had before him a long communication from Mr. Illingworth, which he had not read, but had only seen the signature, and he would have it sealed with their permission. There were other questions to come on connected with the department, which had better be discussed at a special meeting. Mr. Illingworth's letter was sealed, and it was resolved to consider that question and others at a special meeting, to be held on Thursday, September 27th.

**Carlisle.**—The Electric Lighting Committee of the Town Council has agreed that incandescent lights should be fixed on some of the arc lamp standards in the town, being lighted after 11 p.m., and the arcs then switched off.

**Cleethorpes.**—The District Council has resolved to give notice to the Tramway Company of its intention to purchase the site acquired by the company for the purpose of erecting an electricity works, in accordance with the agreement made between the Council and the company in February, 1899. The cost is estimated at £30,000.

**Colliery Plant.**—The Summerlee and Mossend Iron and Steel Company has just introduced at its collieries electric coal-cutting plant of the Clark & Stephen disc-cutter type. This is one of the earliest applications of electricity to coal-cutting in Scotland.

**Crieff.**—At a meeting of the Town Council last week it was resolved to take preliminary steps to obtain a provisional order for the supply of electricity. Two or three years ago the Town Council was offered by Sir Patrick Murray the use of the water from the River Bulwick as a motive power, but owing to doubts as to the sufficiency of the water-power the scheme dropped. The Strathearn Hydropathic Company, however, have utilised the river water for this purpose.

**Devonport.**—The Town Council has received the sanction of the Local Government Board to a loan for the purposes of electric lighting of £67,947, being £15,250 for the purchase of land, repayable within 50 years; and £52,697 for purposes of electric lighting generally, payable within 25 years.

**East Molesey.**—The East Molesey District Council have appointed an expert to report upon an offer made by the Edmundson Electricity Corporation for the public lighting of the district. The company's offer is to supply current for street lighting at 2½d. per unit, the prices to private consumers being 7d., 4d. and 2d. on the maximum demand system. The Callender Electric Lighting Company would supply the plant, and the District Council would have the option to purchase the undertaking at the expiration of 14 or 21 years on paying the capital expended plus 15 per cent. or 10 per cent. respectively. Terms similar to these have been agreed upon at Twickenham, and the corporation is negotiating to supply, from its proposed central station, Brentford, Isleworth, Teddington, Hampton Wick, Hampton, Sunbury, Esher, and the Dittons and Ham. As far as Ham and Hampton Wick are concerned, the local authorities are inclined to obtain any current they may require from the Kingston municipal electric works.

**Enfield.**—The District Council on 13th inst. resolved to apply to the Board of Trade for a provisional order to supply electricity for public and private purposes in the district. A committee was directed to consider the proposals of the Edmonton Electricity Company, the United Electric Light and Traction Company, Limited, and the North Metropolitan Electric Power Distribution Company, and to report as to whether it was desirable to enter into an arrangement with them, also whether it would be more advisable to join with the surrounding districts in promoting a joint Bill.

**Holyhead.**—On a report of the Lighting Committee of the District Council, the question of lighting the town by electric light was under discussion last week. It was stated that the water at the "Cob," separating Holyhead Island and Anglesey Island, could be utilised for this purpose. The Council seemed unanimous in endeavouring to obtain lighting by this method, and Mr. Thunderbolt, of Holyhead, was requested to give the matter his attention, and report to the Council.

**Horsham.**—At the last meeting of the Urban Council the Electric Lighting Committee reported that the approximate cost of the building for the electricity works was now put at £3,100. The plans were adopted, and it was decided that tenders should be invited for carrying out the work.

**Hull.**—The electric tramway employés are agitating for improvements in the conditions of labour, and the Tramways Sub-committee are obtaining information from other towns.

**Kenilworth.**—The District Council has accepted the offer of Mr. W. H. Mitchell to light Whitemoor, a portion of the town, with four electric lamps, he having agreed to supply the electricity at his own cost on certain conditions.

**Liverpool.**—The increased demand for electricity, notably on account of the tramways, has led the Electric Power and Lighting Committee of the Corporation to recommend that, having regard to the increased duties and responsibilities of the staff, incidental to the opening and working of the Pumpfields and Lister Drive power stations, the following promotions be made as from September 1st: Mr. A. Clough, works manager, with a present salary of £460, increasing to £500, to be assistant electrical engineer at a salary of £550, to be increased in 12 months to £600; Mr. R. S. Downe, assistant engineer, to be first assistant engineer at a salary of £320, increasing £40 per annum to £400 (present salary £250, increasing to £300); Mr. C. H. Smith, engineer's secretary, office superintendent, at a salary of £150 (present salary £120); Mr. J. Stirrup, inspector of electric meters, superintendent meter department, at the salary of £130 (present salary £110).

**Longton.**—The Corporation has made application to the Local Government Board for sanction to borrow a sum of £28,500 for purposes of electric lighting, and for approval of the use of certain lands situate at the Corporation gasworks as a site for a generating station, and Mr. H. P. Boulnois, M.Inst.C.E., sat last week to inquire into the application. It was stated that the order authorising the supply was obtained in 1899. Before then the Corporation had retained Mr. Robert Hammond, and upon his report and recommendations the Corporation were now proceeding. The Corporation anticipated that manufacturers' requirements would call for a very large supply of electrical energy. It was proposed to put in the low-pressure continuous system with the most modern appliances, and the formal approval of the Board of Trade had been received to the system. There was no opposition to the application.

**Lowestoft.**—The Electric Lighting Committee having reported to the Town Council that Mr. Hawtayne (the Council's consulting engineer) had submitted revised estimates in connection with the extensions, it was decided to make the application to the Local Government Board on the basis of the amended figures, which amounted to £20,000.

**Middlesbrough.**—A temporary supply of electricity is to be given next month. Mr. Hammond has been asked to report on the question of lighting the principal streets with 40 arc lamps.



loads continually varied throughout the day. All the members of

and steel work was let to Messrs. Clayton, Son & Co., Hunslet, and

**London.**—St. Pancras.—The Vestry has decided to borrow from the County Council the sum of £1,937 for electric lighting (installations for public buildings), at the rate of 3½ per cent. per annum, and that the repayments be spread over as long a period as the County Council and the Treasury will sanction.

Bermondsey.—The Electric Lighting Committee at a meeting of the Vestry on Monday, reported having received specifications from the consulting engineers (Messrs. Kincaid, Waller & Manville) for the supply and erection (1) of steam dynamos, battery charging motor booster, and balancer, and (2) of steam and other pipes, feed pumps, water tank and sundry ironwork. With regard to the former contract it was pointed out in a report by the engineers that this provides for the supply of two high-speed steam dynamos, capable of developing 150 kw., and one smaller set capable of giving an output of 75 kw. A balancing set is also provided, together with a booster set for charging the battery consisting of two boosting dynamos driven by a motor. Mains are being put down sufficient for supplying 8,000 8-c.p. lamps alight simultaneously, which is equivalent to about 10,500 lamps connected to the mains. The plant now proposed will be capable of supplying this number of lamps in conjunction with a battery of accumulators. The Committee recommended the Vestry to approve the report, and to invite tenders for carrying out the work, and this was agreed to. It was also decided to advertise for a resident electrical engineer at a salary of £250 per annum.

Shoreditch.—The Vestry has decided, in order to meet the increasing demands for supply of current, to purchase 25 10-ampere and 25 25-ampere meters at a cost of £5 each. In reply to questions as to outstanding accounts for current supplied, the accountant stated that the notices served upon consumers had expired, and cutting off would commence on the following day.

Hackney.—Considerable discussion took place at the meeting of the Vestry on the recommendation of the Electric Lighting Committee to receive and open tenders for part of the equipment of the electricity works. Mr. Richmond moved that the opening of the tenders be deferred six months. The amendment was rejected, and the committee's report carried, the tenders being referred to the Electric Lighting Committee and the engineer to consider and report upon.

**Medomsley.**—The Consett Iron Company have made an offer to light portions of the township of Medomsley with electricity from their Westwood Colliery. The company will supply the plant and current, but the Council will bear the expense of erecting the poles and fixing the wires.

**Neath.**—At a special meeting of the District Council last week it was resolved to apply to the Local Government Board for a provisional order for the electric lighting of the district. A proposal previously made by the Town Council inviting co-operation was refused.

**Nottingham.**—The City Council is putting down two new refuse destructors, from which it is hoped to get 450 to 500 h.p. for electric lighting or traction.

**Penang.**—At a recent meeting of the Municipal Commission it was decided to introduce the electric light into Penang. They also voted a sum of Rs. 300,000 to cover the cost of an electric lighting scheme.

**Quebec.**—Since October, 1899, says *Engineering*, the Engineering Contract Company has been constructing a dam on the Chaudière, at the back of Quebec, for the Canadian Electric Light Company. The structure is to be 800 feet in length. At the extremity of the dam another similar wall 175 feet in length terminates at right angles with a mass of rock. There is still another dam 90 feet long from which passes a pipe 8½ feet in diameter and 350 feet long. Two other similar pipes will be constructed to meet the anticipated requirements of the company. A contract for the power house was let recently to Mr. J. Paquet, of Levis, who is to commence work at once. There are to be two turbines of 1,460 h.p., and machinery of the best class is to be installed.

**Rainhill.**—At a special meeting of the Parish Council an agreement between the Council and the British Insulated Wire Company for the lighting of the township was formally executed.

**Ripon.**—A special meeting of the City Council has been called for October 11th, to take into consideration the expediency of applying for a provisional order to authorise the supply of electrical energy for public and private purposes. The Council has been led to take action by the North British Electric Supply Company, who have notified their intention of applying for an order.

**Hyde.**—At the monthly meeting of the Town Council on Monday, it was reported that a deputation, consisting of the Mayors of Hyde, Stalybridge, Dukinfield, and Mossley, and the four town clerks, had had an interview with Sir Courtenay Boyle, secretary of the Board of Trade, for the purpose of ascertaining whether or not the proposed joint electric lighting and traction scheme could be carried out by provisional order. The question of proceeding by private Bill was considered, and Sir Courtenay Boyle stated that he quite approved of the four Corporations combining together, but was of opinion that the Board of Trade had not the power to grant a provisional order for the suggested joint scheme. It would be necessary to obtain a private Bill to carry out the requirements of the four Corporations. The deputation's report was approved and adopted, and it was resolved that application be made to Parliament. The town clerks of the respective Corporations had been instructed to prepare a draft agreement to be entered into by the four authorities as to the appointment of a joint committee to carry out the proposed scheme upon the bases recommended. The town clerk was empowered to take all necessary steps in support of the light railway application at a public inquiry shortly to be held at Hyde.

**St. Helens.**—The annual statement of the Corporation accounts shows that the total income on the electricity revenue account was £5,196, including £3,420 from the sale of electricity, and £1,409 for power supplied to the St. Helens Tramway Company. The expenditure, including £1,719 for generation of electricity, £318 for distribution, and £626 for management, amounted in the aggregate to £5,185, leaving a balance profit of £10. The income on the tramways revenue account was £21,167, and expenditure £20,130, leaving a credit balance of £1,037. The income included items of £2,661 rent (less tax) paid by the New St. Helens and District Tramways Company, Limited, and £17,064 for material.

**Santiago.**—*Commercial Intelligence* says that at Santiago, the Chilian Electric Traction and Light Syndicate, Limited, is to undertake extensive improvements which will require a considerable amount of material, machinery, &c. It has been decided by the company to obtain water power of about 50,000 h.p. from the River Maipu, to generate current for the electric lighting of Santiago and a complete electric railway service.

**Slaithwaite.**—The District Council has refused its consent to the proposal of the Northern Counties Electricity Supply Company to apply for a provisional order for the electric lighting of the village, on the ground that if the company could make the undertaking pay, the Council could do the same! This is open to question.

**Standish.**—The District Council has resolved to make application for a provisional order in the next session of Parliament in order to enable it to supply and distribute electricity within the district.

**Tillicoultry.**—An electric supply company proposes to erect a generating station in Tillicoultry for the electric lighting of the burgh, and has applied for the support of the local authority in the matter of the provisional order.

**Tiverton.**—The Lighting Committee of the Town Council has received the report of the engineer (Mr. Adams) appointed by the Council on the electric lighting of the town. He gives three schemes, the power being supplied by water, steam and gas respectively, and from his estimates the Committee comes to the conclusion that the water scheme is the only one which gives promise of yielding a profit from the commencement. The scheme, if adopted, will necessitate the construction of a weir across the River Exe, which flows through the town, and correspondence has taken place with the Board of Trade with a view to ascertaining the opinion of that body, whose decision is awaited.

**Truro.**—The Town Council has apparently taken another step towards the ultimate adoption of electric light for the city. The Lighting Committee recommended "to the favourable consideration of the Council," at a meeting last week, the report prepared by Mr. Headley, of St. Austell. This document dealt not only with the lighting of the city by electricity, but also with an electric traction scheme from Malpas to the railway station. It advised that the lighting be confined to the habitable area, and to that portion from which a private demand for lighting or power might be expected. The capital expenditure on the lighting scheme, Mr. Headley estimated, would be £17,500. He calculated an annual revenue from public lighting of £502 18s. 9d; house lighting, £3,000; power, £200; meter rents and sundries, £1,507; total, £3,822 18s. 9d. Estimating the expenditure at £3,140, a profit of £682 remained. The Truro Corporation have secured electric lighting powers, and have now appointed a special committee to consider that portion of the report of Mr. Headley dealing with lighting. The question of electricity for purposes of traction is not to be gone into at present.

**Worksop.**—The tenders in connection with the electric lighting works have been referred to a special meeting of the Council.

**York.**—Owing to the exceptional demand which has been made on the supply of electricity, the Corporation will be unable to connect any more consumers until the new plant is delivered.

## ELECTRIC TRACTION NOTES.

**Bangkok.**—A concession for an overhead electric tramway in Bangkok is to be granted to Captain L. de Richelieu and Mr. A. Westenholz, acting on behalf of a syndicate. Work will be commenced as soon as the concession is signed, and the line is expected to be ready in about 18 months.

**Cardiff.**—Mr. Ellis, who was recently appointed tramway engineer to the Corporation, presented his first report to the Tramways Committee on Friday last. He said that the most important factors to be considered in the designing and equipment of the electric tramway system were:—Site of power station, power station buildings, plant at power station, main car depôt, overhead electric equipment, underground system of electric distribution, and cars. He recommended the Roath Brook site as the one best suited for the purposes of a power station. In regard to the machinery, Mr. Ellis recommended slow speed engines, inasmuch as the tram-

loads continually varied throughout the day. All the members of the Committee expressed their satisfaction with the excellent report. The report having been adopted, it was decided to circulate copies among the members, and that the engineer be instructed to prepare specifications of the machinery.

**Crewe.**—The Town Council is considering the proposed scheme of electric traction, and has had an interview with Mr. C. Hopkinson, who is to draw up a report on the subject.

**Brighton.**—The Traction Committee of the Town Council have arranged to take electricity from the Corporation supply for working the tramways at 5d. per unit for the first hour's consumption and 1d. per unit afterwards. The Lighting Committee have been asked to be ready to supply the current by August 1st next. The estimated cost of wood paving for the tramway area is £44,667 16s.

**Germany.**—The *Financial Times* says that an exhaustive investigation as to the causes of accidents on electric tramways has just been completed by the Society of German Tramway and Secondary Railway Administrations, an institution which now comprises 100 different tramway and subsidiary railway undertakings. The results are contained in a report which relates to the year 1899, and embodies returns from 58 distinct tramways, and which was submitted to the general meeting of the society held in Wiesbaden a few days ago. It appears from the report that during 1899 accidents occurred to 973 passengers and 871 other persons, or 52·3 per cent. and 47·2 per cent. respectively. Of the total of 1,844 no less than 126 were killed, whilst 147 passengers and 146 other persons were severely injured. The report concludes that as compared with 1898 there was a diminution last year in the number of accidents arising from persons unlawfully entering or leaving tramcars and from too high a speed being used in passing round curves, and a reduction in the casualties to children was also noticed. The result in the latter case is attributed to the adoption of improved mechanical braking arrangements. There was, however, an increase in the accidents due to collisions, the larger number affecting pedestrians, and especially cyclists.

**Gosport.**—The District Council have had under consideration the proposal of the Electrical Power Distribution Company to take over the Gosport electric lighting order and the tramways. It was pointed out that the Council must act with the greatest promptitude, as after November 22nd next they would be unable, under the Act, to do anything in the matter of the tramways until another seven years had elapsed. It was decided that a meeting of the Council, in committee, should be held to consider the proposals.

**Herne Bay.**—A Westminster solicitor (Mr. R. B. Johnson) has notified the Herne Bay District Council of his intention to apply, on behalf of clients, for powers to construct an electric tramway or light railway between Herne Bay and Canterbury, with provision for public and private lighting if desired.

**Kilmarnock.**—At the last meeting of the Town Council Mr. Lea, of the British Electric Traction Company, explained a proposed system of electric tramways between Beansburn and Riccarton, with a spur line from the Cross to Hurlford, and the terms on which the company would be prepared to carry out such a scheme. The Council will consider the matter.

**Kirkcaldy.**—The Council has resolved to widen the portion of High Street between Redburn Wynd and Port Brae on the north side, and to west of Redburn Wynd, so that the trams can be run both ways at that part of the route. The cost of purchasing property was estimated by Prof. Kennedy at about £21,000.

**London.**—Bermondsey. The General Purposes Committee reported at a meeting of the Vestry on Monday, having received a letter from the London County Council intimating the intention of the Council to apply in the next session for powers to construct tramways for a conduit system along the new street, being formed between Bermondsey New Road and Tooley Street. The committees of the Council, who have the matter under consideration, after asking for the support of the Vestry, stated that:—

The making up and paving of the carriageway of the new street will shortly be put in hand, and in order to avoid the necessity of breaking up the concrete of the carriageway soon after its completion for the purpose of laying the tramways, the Committees proposed that the construction of the electrical conduits, with all necessary drains, pits for road boxes and grooves for the rails shall be proceeded with at once in anticipation of the powers being granted by Parliament. It is not intended, however, that the slot rails and tram rails shall be laid until Parliamentary sanction shall have been obtained thereto, but if the local authorities concur, the Committees propose to lay a double line of tram rails in that portion of the thoroughfare which is now occupied by the tramway of the Southwark and Deptford Company provided the Council's negotiations for the purchase of that company's tramway shall have sufficiently advanced by the time it becomes necessary to repave Bermondsey New Road in connection with the proposed widening of that thoroughfare. With regard to the portion of the paving between the rails, the Committees are of opinion that this should consist of granite setts, because, if the slot rails for the conduit are to be put down at a later date, wood paving will not be suitable for the portion of the carriageway in question.

On the recommendation of the General Purposes Committee, the Vestry resolved to concur in the laying of a double line as suggested, with granite setts as the paving between the rails, to ask the Council to obtain the motive power from the Vestry, and to reserve the right of action as to an overhead or conduit system until the Council makes application to Parliament.

**Leeds.**—We read that new engines are at present being erected at the generating station at Crown Point. These will be supplied with steam from nine boilers, each 30 feet by 8 feet diameter. A new boiler house has to be erected, and last week the Works Sub-Committee of the Tramways Committee met to consider the tenders received for its construction. The contract for the iron and steel work was let to Messrs. Clayton, Son & Co., Hunslet, and the building trades' contract to Messrs. Irwin & Co., Burley Road. The amount of the contracts is a little over £10,000. The boiler house will have a second storey which will form a coal store, and there 2,000 tons of coal can be stored for an emergency.

**Newport.**—Mr. H. F. Parshall has been definitely appointed engineer to the Town Council for its proposed tramway scheme, which provides for 35 cars at an estimated cost of £85,000.

**Ormskirk and Southport.**—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order for the construction of light railways in Lancaster, from Ormskirk to Southport.

**Plymouth.**—An unusual mishap occurred last week at the electricity works, when the armature of a booster burst. The first indication of something wrong was apparently given by the overheating of the field magnet coils. Mr. Smith, who was in charge at the time, promptly commenced to switch off the current, but before the operation could be completed the explosion took place, scattering copper commutator segments in all directions, breaking windows, and wrecking the booster. The circuit breakers in the tramway circuits all came out, but the supply was resumed in a few minutes. The breakdown was said to be due to a faulty casting in the commutator, but how could that cause the field coils to overheat? It seems more probable that the coils were short-circuited, the excitation was diminished, and the motor consequently raced until the defective casting gave way. Fortunately no one was injured.

**St. Helens.**—As an electric car was being taken from the sheds to the line on 4th inst., through inexperience on the part of the guard, the trolley pole got on to the wrong wire, and swung outwards. It came back with a swing to its proper line, bringing down nearly all the wires at the junction and breaking the connections with nearly the whole of the system. There were other nasty effects, which occupied three hours in repairing.

The borough engineer and the electrical engineer have been instructed to prepare an estimate of the cost of laying and equipping tramways along Corporation Street to the present tramways in that street, and from Raven Street along Parr Street to the top of Bishop's Bridge. It has been decided to apply to the Local Government Board for sanction to borrow money for carrying out these extensions.

**Southampton.**—At a Town Council meeting last week the Tramway Committee reported that, having considered the subject of proceeding with further tramway extensions, as sanctioned by the Southampton Corporation Tramways Order, 1900, Messrs. Kincaid, Waller & Manville, the consulting engineers, had, at their request, prepared specifications for the construction of additional lines, at an estimated cost of £19,180. Should it be decided to lay wood in place of granite, the additional cost would be about £2,000. The recommendation was adopted without opposition.

**Walsall.**—The General Purposes Committee have appointed a sub-committee to settle the terms of the lease of the South Staffordshire Tramways (Lessee) Company, Limited, of the tramways to be acquired by the Corporation from the South Staffordshire Tramways Company under the agreement scheduled to the Walsall Corporation Act, 1900; and also to consider and report as to whether any and which of the authorised extensions shall be carried out by the Corporation. They have also authorised the Finance Committee to make arrangements for raising on mortgage or otherwise the amount of £18,500, the purchase money to be paid to the Tramways Company.

**Windermere and District.**—The Bowness and Ambleside Urban District Council has received notice that the British Electric Traction Company does not intend to proceed with the promotion of the Windermere and District Light Railway scheme in its present form. It is proposed to amend it so as to be in accordance with the views of the local authorities concerned.

## TELEGRAPH AND TELEPHONE NOTES.

**German Cables.**—The German Government is now, according to the *Financial Times*, taking practical steps with a view to establishing submarine cable communication for the German sphere of interest in China. At the request of the Imperial Postal Administration, the Mulheim works of Felten & Guilleaume have just manufactured 472 kilometres of cable, which is now being shipped from the Rhine to Rotterdam, where it will be transferred to the new German cable-laying steamer *Podbielski* for transport to the Far East. It is intended to commence the laying of this cable at the end of October from Chifu to the Kungkungtau Islands on the one hand, and to Tsingtau on the other. In addition to this, the Nordenham factory of the North German Submarine Cable Works is now manufacturing a cable of a length of 715 kilometres for the purpose of connecting together Tsingtau and Shanghai. It is expected that the laying of the cable will be completed in the spring of next year.

**Indian Telegraphs.**—*Indian Engineering* says that orders for the erection of the new telegraph wire from Bombay to Madras, a distance of 800 miles, required in connection with the abnormal traffic with the Far East, were given on July 7th. The work was commenced on July 15th and completed on August 14th.

**Proposed Telephone between Sydney and Melbourne.**—The Premier of Victoria has conferred with the Postmaster-General with the view of seeing whether it is practicable to establish a telephone between Sydney and Melbourne. It is stated that tenders for the construction of the line are now being invited by the Postmaster-General. The cost is put at £24,000.

**Portsmouth Telephones.**—The Town Council last week passed a motion in favour of establishing a municipal telephone exchange.

**Telegraphic Communication with Siberia.**—The *Times* quotes the *Novoe Vremya* as saying that the vast increase of correspondence by post and telegraph between European Russia and Siberia has for some time past demanded that some special measure should be taken to cope with it. The old postal telegraph service has been found quite inadequate, even for the ordinary everyday needs. The officials, overwhelmed with work far beyond their powers, have been quite unable, in spite of all their efforts, to perform the duties required of them. Not only were the officials far too few, but also the instruments and wires. In the old days the demands on them were subject to a gradual annual increase, but for some time past the demands have become daily more and more pressing. The public have naturally complained of the extremely unsatisfactory nature of the telegraphic service, but the officials were not to blame. Suddenly the disturbance in China arose; the main line was then occupied almost exclusively with Government despatches, other messages accumulated in heaps and had finally to be sent on by post. The matter is now receiving the special attention of the Government. In July the laying down of additional wires was commenced, and officials and skilled workmen have since been hurried from all parts of Russia so that more adequate accommodation might be available as soon as possible. The Siberian papers already report an improvement.

**Telegraphic Communication with the Far East.**—The Eastern Extension and Great Northern Telegraph Companies announce that the laying of the proposed submarine cable between Shanghai and Chefoo has now been successfully completed, and the line opened for traffic. This, with the Chefoo-Taku cable recently laid by the companies, provides submarine telegraphic communication to Chefoo and Taku—available for international traffic—entirely independent of the Chinese landlines, and without any addition to the existing tariffs. The companies also announce the laying and opening of branch cables between Chefoo and Wei-Hai-Wei, and Chefoo and Port Arthur.

**Telegraphic Interruptions and Repairs:—**

| Cables. | Interrupted. | Repaired. |
|---|---|---|
| **South American:—** | | |
| Cayenne-Pinheiro | Oct. 11, 1899 | Sept. 17, 1900 |
| Pará-Maranham | March 1, 1900 | |
| Ceará-Maranham | Feb. 20, 1900 | |
| Direct Cable Pernambuco-Para | Sept. 19, 1900 | |
| **West Indies:—** | | |
| Mole St. Nicholas-Cape Haitien | March 6, 1900 | |
| Latakia-Cyprus | June 20, 1899 | |
| St. Louis (Senegal)-Bathurst | Aug. 25, 1900 | |
| Tarifa-Tangier | Jan. 8, 1900 | |
| **Landlines:—** | | |
| **Chinese:—** | | |
| Tientsin-Pekin | June 12, 1900 | |
| Pekin-Kalgan | June 14, 1900 | |
| Kalgan-Maimatchin | June 30, 1900 | |
| Tientsin, *via* Shanghai | June 16, 1900 | |
| Tientsin-Niuchwang | June 18, 1900 | |
| **South American:—** | | |
| Communications with all offices of Columbia beyond Buenaventura | January 29, 1900 | |
| Ecuador landlines | March 18, 1897 | |
| Landlines south of Macahé (Brazil) | April 20, 1900 | Sept. 14, 1900 |
| Landlines south of Serena | July 30, 1900 | |
| **Siberian—** | | |
| Irkoutsk-Werkhne-Oudinsk | Sept. 12, 1900 | Sept. 14, 1900 |
| Communication "*via* Hanekine" interrupted on Persian territory | Feb. 24, 1900 | |

## CONTRACTS OPEN AND CLOSED.

### OPEN.

**Aberdeen.**—September 29th. The Electric Lighting Committee wants tenders for two 200-kw. direct coupled continuous current generators, and one 120-kw. balancing set; one 420-kw. direct coupled generating set. All Willans engines. See "Official Notices" August 24th.

**Aberdeen.**—October 17th. The Tramways Committee wants tenders for 25 electric tramcars, and electrical equipments for six horse cars. See "Official Notices" to-day.

**Birkenhead.**—October 2nd. The Corporation wants tenders for feeder mains. See "Official Notices."

**Bradford.**—October 9th. The Corporation wants tenders for an engine and dynamo and switchboard apparatus, &c., for their destructor works. See "Official Notices" to-day.

**Bray.**—October 4th. The District Council wants tenders for electrical supplies for the electric light works for 12 months. See "Official Notices" to-day.

**Brighton.**—October 1st. The Corporation invites tenders for electric motor cars, steel rails, fishplates, &c. See "Official Notices" September 14th.

**Budapest.**—October 15th. The Hungarian Minister of Commerce is prepared to receive tenders for the installation of two telephone exchanges, local and interurban, complete in all respects. See "Official Notices" August 3rd.

**Bulgaria.**—October 15th. The municipal authorities of Varna are inviting tenders until October 15th for the concession for the electric lighting of the town during a period of 40 years

**Bulgaria.**—October 22nd. Tenders are invited by the Municipality of Philippopolis for a concession for electric lighting and a tramway in that town.

**Dublin.**—October 4th. The Electric Lighting Committee wants tenders for the supply and laying of mains and accessories. See "Official Notices" August 31st.

**Durham.**—The clerk to the Medomsley Parish Council is prepared to receive tenders for electric lamps, posts, cables, &c., necessary for the lighting of certain roads.

**Eastbourne.**—October 4th. The Corporation wants tenders for a water-tube boiler and fittings, 400-kw. steam alternator and switchboard. See "Official Notices" September 7th.

**Fulham.**—September 25th. The Vestry invites tenders for plant for unloading and storing coal at the electricity works. See "Official Notices" September 14th.

**Glasgow.**—September 28th. The Corporation are prepared to receive tenders for the supply and fitting up of the power station piping required at Pinkston. Specifications, &c., on application to Mr. John Young, general manager, 88, Renfield Street, Glasgow. A bank draft for five guineas, payable to the General Manager, must accompany each application for specifications.

**Grimsby.**—October 6th. The Corporation wants tenders for wiring the free library. See "Official Notices" to-day.

**Hackney.**—October 3rd. The Electric Lighting Committee wants tenders for electricity supply mains. See "Official Notices" September 14th.

**Hampstead.** — September 27th. The Vestry invites tenders for eight marine boilers, piping, feed-heater or detartariser, fuel economiser, and tanks. See "Official Notices" August 24th.

**Hoylake and West Kirby.**—October 4th. The District Council wants "free wiring" offers. See "Official Notices" to-day.

**Hull.**—September 27th. The Corporation wants tenders for certain steam and water pipes, pump, water softener, &c., for electricity works. See "Official Notes" August 24th.

**Ilford.**—October 8th. The Council wants tenders for direct current meters and cut-outs. See "Official Notices" to-day.

**London.**—September 24th. The L.C.C. is inviting tenders for the supply of mains for the installation for the Victoria Embankment and Westminster Bridge. See "Official Notices" August 31st.

**London County Council.**—September 22nd. Tenders are wanted for boilers, engines, dynamos, &c., at the Horton Estate Epsom, Surrey. See "Official Notices" August 10th.

**Manchester.**—October 1st. The Tramways Committee wants tenders for the supply of cast-iron bases for tramway poles. See "Official Notices" to-day.

**Salford.**—October 2nd. The Cleansing Committee of the Corporation wants tenders for a two or three-cell refuse destructor. Also for a six-cell destructor on the forced or accelerated draught principle, together with necessary boilers, &c. See two "Official Notices" August 31st.

**Sheffield.**—October 6th. The Corporation wants tenders for two two-phase steam alternators and exciters of 600 kw. each, and the alteration of present single-phase plant to two-phase plant. See "Official Notices" September 14th.

**Spain.**—October 11th. The *Madrid Gazette* publishes a notification of the conditions on which a contract for the electric lighting of the town of Azuaga will be awarded. Tenders will be received by the municipality up to 11th prox., the upset price being 9,000 pesetas annually for electric lights of 3,000 c.p., distributed in incandescent lamps of 10 and 16 c.p.

**Suffolk.**—October 5th. The Visiting Committee of the County Lunatic Asylum wants tenders for the wiring and fitting of the County Asylum at Melton for electric lighting. See "Official Notices" September 14th.

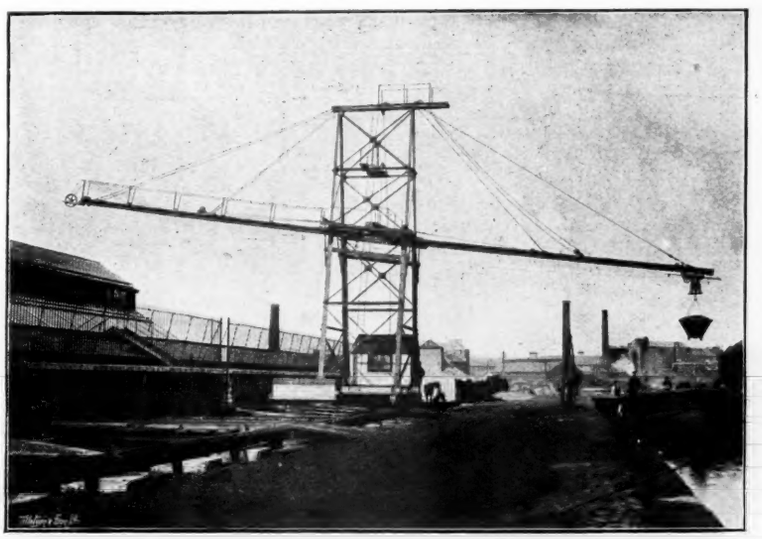
**Sunderland.**—September 21st. The Corporation wants tenders for triple expansion high speed, direct current dynamos, Lancashire boilers, feed pumps. See "Official Notices" August 31st.

**Walthamstow.** — September 25th. The Council is inviting tenders for gas plant, gas engines, dynamos, switchboards, boosters, balancer, and measuring instruments. See "Official Notices" August 31st.

(*Continued on page* 470.)

## THE NEW ELECTRICITY WORKS OF THE GLASGOW CORPORATION.

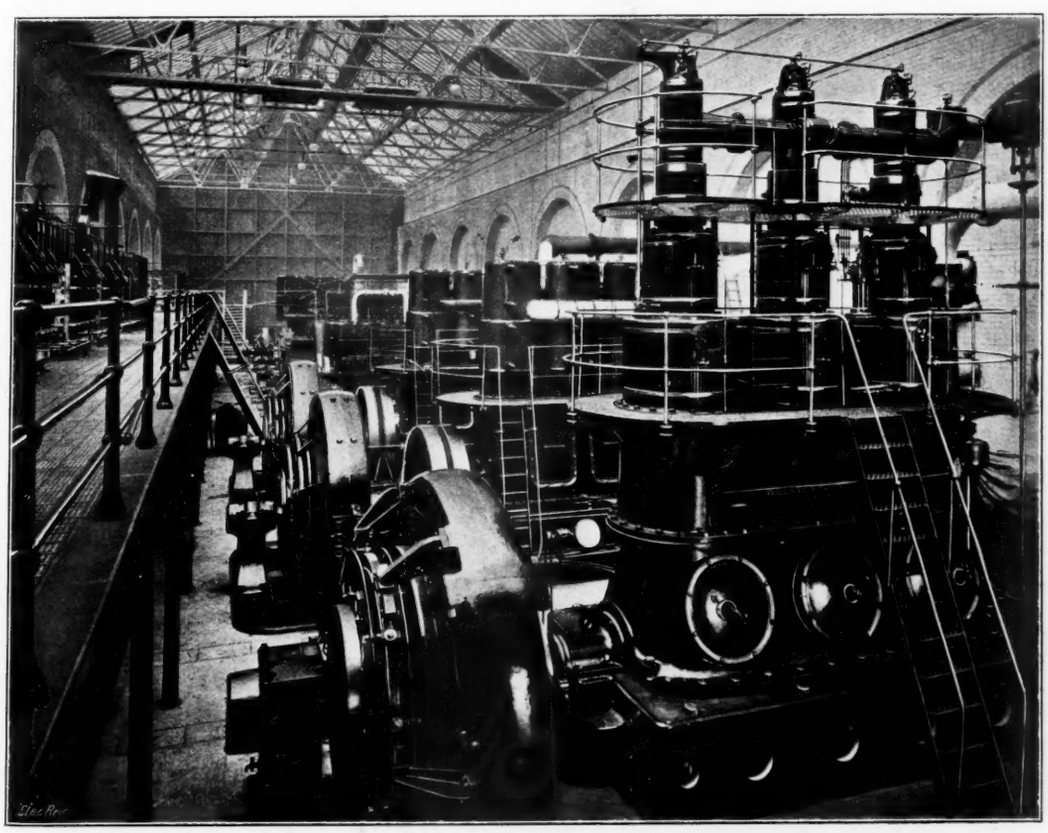
It is one of the most cherished traditions of the Corporation of Glasgow that the city over which it rules shall ever be in the foremost rank of progress; and this is no empty theory, but a living principle constantly present in the deliberations of the councillors. This being so, it is no matter for surprise that when we went to Glasgow last week in order to be present at the inauguration of the new electricity works, we found a scheme in progress of the first magnitude, providing for the ultimate installation of upwards of 50,000 H.P. in two large generating stations; one-third of the plant is already installed, or on order.



Temperley Transporter.

The need for this large extension of the electricity supply is not of recent growth; as long ago as 1897 the existing plant at the Waterloo Street station was seriously overloaded, and since that time strenuous efforts have been made to cope with the increasing demand. Before proceeding with the detailed description of the new stations, we think it will be of interest to briefly review the past history of electricity supply in Glasgow, on the lines of an excellent brochure prepared by the chief engineer, Mr. W. A. Chamen, for the opening ceremony.

Apart from isolated installations, the first important step towards the general supply of electricity was made by Messrs. Muir and Mavor in 1879, the principal consumer being the General Post Office (the first post office in the kingdom to be lighted by electricity). In 1888 the company of Muir, Mavor and Coulson, Limited, was formed to take over the business, and a high pressure supply with overhead wires was commenced. In 1890 the Corporation obtained an electric lighting order, and purchased the company's undertaking, which at that time had a capacity of 297 KW., with a lamp connection of 8,904 8-C.P. lamps, and an annual sale of over 400,000 units. It is interesting to note that this company was the first to introduce the maximum demand system of charging, the maximum demand being calculated from the number of lamps installed.

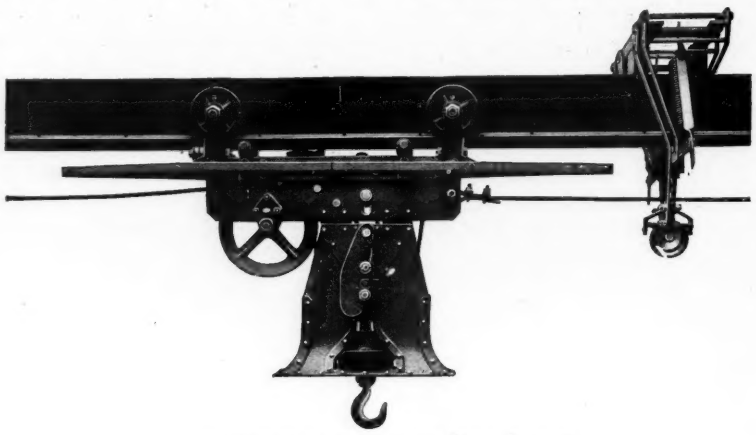


General View of Engine Room.

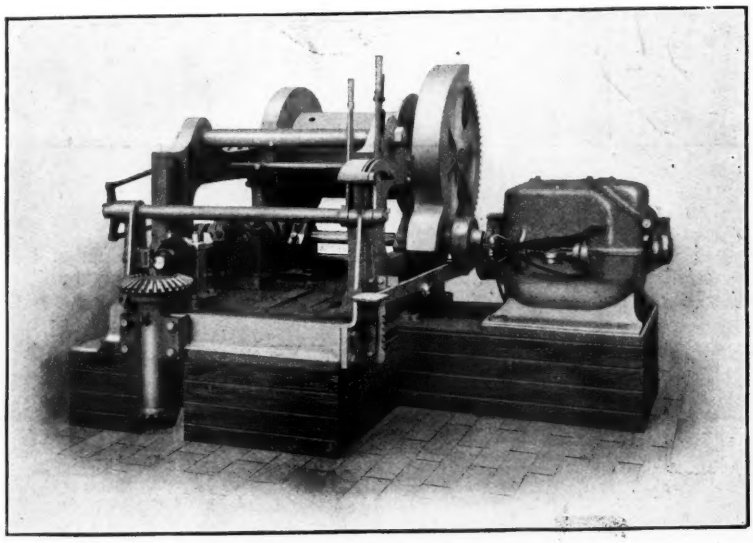
G

The Corporation in 1892 commenced the erection of a direct current supply station, with Prof. A. B. W. Kennedy as consulting engineer and Mr. W. Arnot as resident electrical engineer. In February, 1893, some of the streets were lighted by arc lamps, and in April following the general supply was inaugurated, the alternating supply being discontinued a few months later. The undertaking grew rapidly, and from time to time the plant was added to, until, in 1897, the whole of the space at Waterloo Street was fully occupied, the capacity of the station then being 3,300 H.P. An important change took place in 1896, when the electrical department, which up till then had been in the hands of a sub-committee of the Gas Committee, was placed under the control of a special Electricity Committee, with Bailie Maclay as convener, Bailie Willock as chairman of the Sub-Committee on Works, and Councillor Finlay as chairman of the Sub-Committee on Finance, as at present.

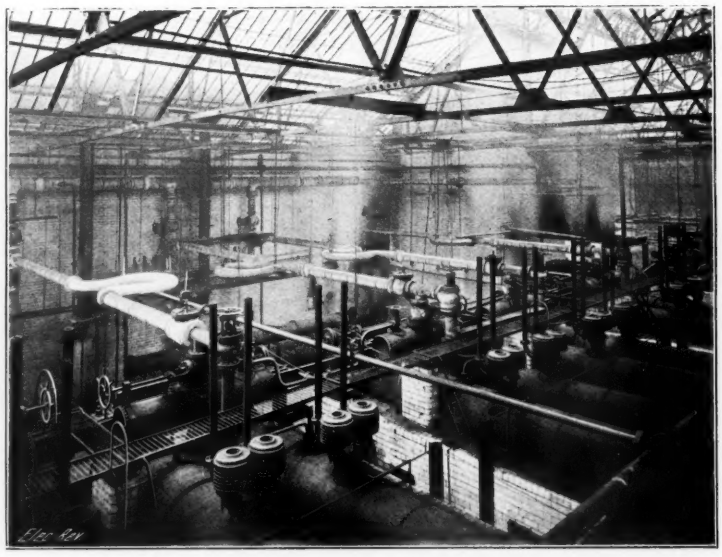
The new management soon found extensions necessary, and put down two temporary battery sub-stations to assist the generating station at times of heavy load. Meanwhile a site of 4½ acres was acquired at Port Dundas, on the Forth and Clyde Canal, and another of 2 acres in Pollokshaws Road, adjoining the Kilmarnock Joint Railway, on which to erect stations for the supply of the areas north and south of the river respectively. Mr. W. Arnot having resigned his position in 1897, Mr. W. A. Chamen was appointed electrical engineer to the Corporation in January, 1898.



Fallblock Traveller and Rope Carrier.



Electric Engine for Transporter.



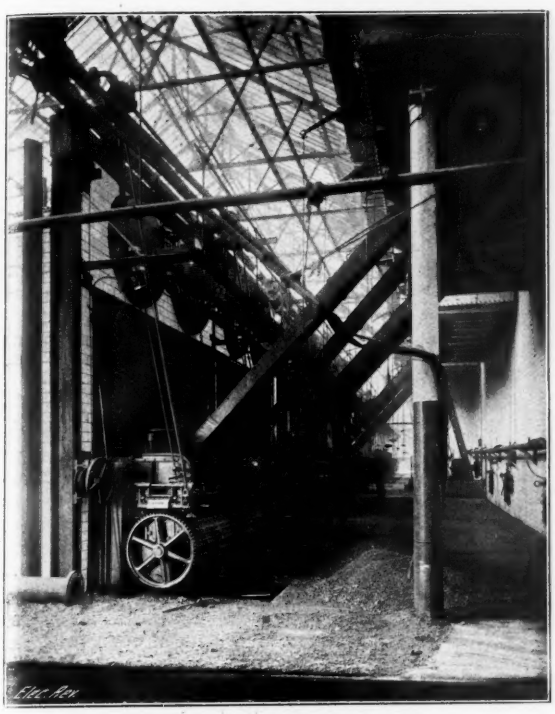
Arrangement of Steam Piping, Etc.

It was now a matter of urgent necessity to put down plant to cope with the following winter's load—so urgent that it was impossible to wait for the buildings to be erected or for machinery to be specially constructed. Tenders were invited for such plant as could be delivered quickly, and this, to the extent of 2,000 H.P. was housed within a temporary wooden shed on the site of the new works at Port Dundas. By this means the continuity of supply was maintained through the winter, though not without occasional overloading of the Waterloo Street plant.

The pressure adopted for the new scheme, which will eventually supply the whole of Glasgow, was the highest permitted by the Board of Trade—250 volts at consumers' terminals, on the three-wire system. This course was decided upon on account of the large area to be supplied. Some inconvenience resulted therefrom, as the Waterloo Street station supplies consumers at 100 volts, so that the mains from the old and new stations cannot be connected, and the operation of changing over is somewhat tedious and troublesome; but in course of time these drawbacks will cease to exist, and the advantages of the higher pressure in respect of a steadier light at a lower cost are bound to be realised. Already about 1,500 consumers are supplied from the Port Dundas station, and the Pollokshaws Road works will commence supply next month.

The new works for supply on the north side of the river are situated on a slope, along the ridge of which runs the Forth and Clyde Canal; the front of the station faces Edington Street, which

runs parallel with the canal. The buildings were designed throughout by Mr. A. Myles, to the instructions of the electrical engineer, and were built by Messrs.

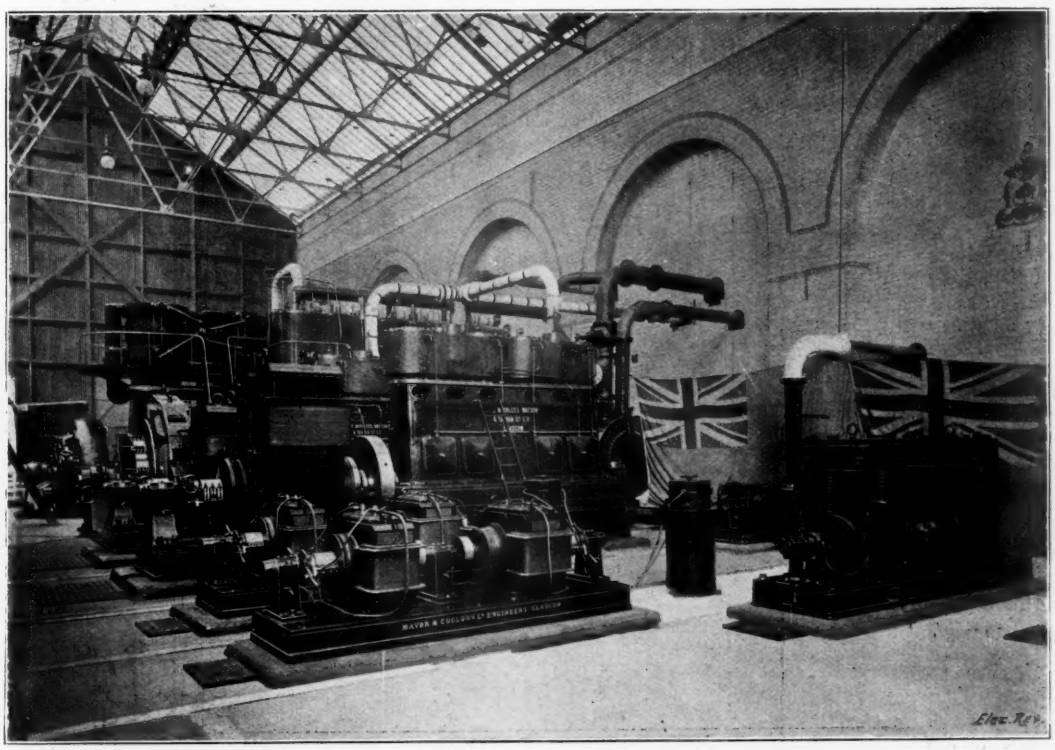


Babcock & Wilcox Boilers.

John Porter & Sons, of Glasgow. Only the centre portion, about one-third of the whole, has been built as yet, but excavations are in progress for the foundations of one of the remaining portions.

be seen that coal received in barges is conveyed by a Temperley transporter either to the coal store or to the tanks from which the boilers are fed; the boilers and engines are arranged in parallel rows, the communication between them being as direct as possible, while a large main steam pipe provides means for cross-connecting. Next to the engine house are the battery rooms and offices.

The coal handling and storing arrangements are very complete. The coal, which consists of "singles" and "pearls," is very small, but remarkably free from dust; it is brought to the wharf in barges carrying 60 or 70 tons. Here it is shovelled into skips holding about 17 cwt. per load; each skip, as it is filled, is lifted by the transporter, hauled along the beam to the upper end, and lowered over a travelling hopper fitted with a Pooley weighing machine, into which the coal is discharged. The skip is then hauled up again, is automatically caught by the trolley, and runs down to the outward end of the beam by gravitation; meanwhile the coal is dropped into one of the hoppers situated over the boiler house wall, whence it is deflected through chutes into either the store or the tanks as desired, by a hinged flap in the hopper. The complete operation, from lifting the full skip from the barge, to the return of the empty skip, is performed by means of one rope driven by the engine on the power platform, and only one man is required to work the transporter. A load can be taken up or let down at every 5 feet along the beam. There is an automatic arrangement by which, as soon as the fall block enters the hood of the traveller, the weight of the load is taken off the hoisting rope and the load is suspended direct from the traveller running on the beam, and it automatically unlocks when the load is required to be lowered. The transporter is operated by a 25-h.p. railway motor made by the General Electric Company, of America, which runs at 500 revolutions per minute, taking 47 amperes × 500 volts at full load; the motor is governed by a British Thomson-Houston magnetic blow-out traction controller. One of our figures shows the type of engine used, but an arrangement has been added for lifting and lowering the arm over the water. The engine is capable of lifting a load of 25 cwts. at a speed of 300 feet per minute, and hauling it along the



Mirrlees, Watson & Yaryan Engine and Crompton Dynamo; Mavor & Coulson Boosters, and Silvertown Balancer.

The plan and section which we give on a later page show the arrangement of the present buildings and of the future extensions, together with their principal dimensions. It will

beam at a speed of 600 feet per minute. In regular working it takes about two hours to empty a 70-ton barge.

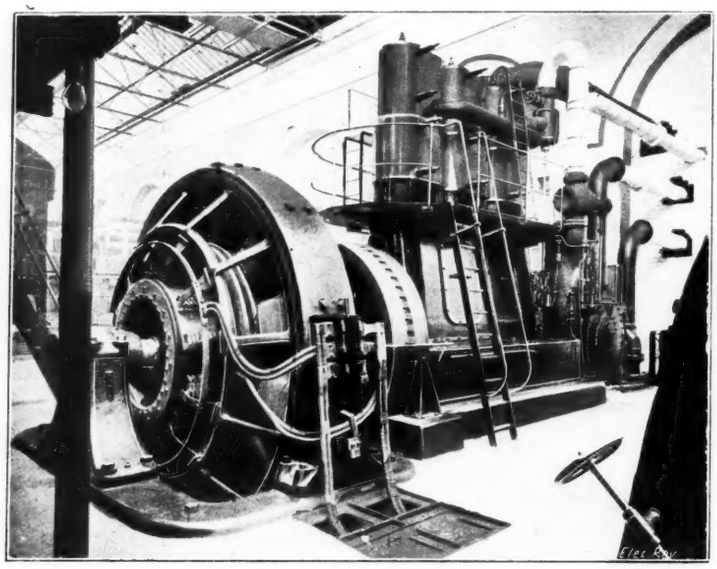
The transporter runs on rails, with a gauge of 19 feet

4 inches, extending the whole length of the coal store, and is propelled by its own gearing; the weighing hopper is also provided with a line of rails over the coal chutes. The outward half of the transporter beam is hinged near the tower, so that it can be hauled up out of the way of the masts of barges when not in use. The overhang on the water side is 45 feet, on the land side 41 feet, and the distance between the centres of the tower uprights 12 feet, giving a total effective travel of 98 feet.

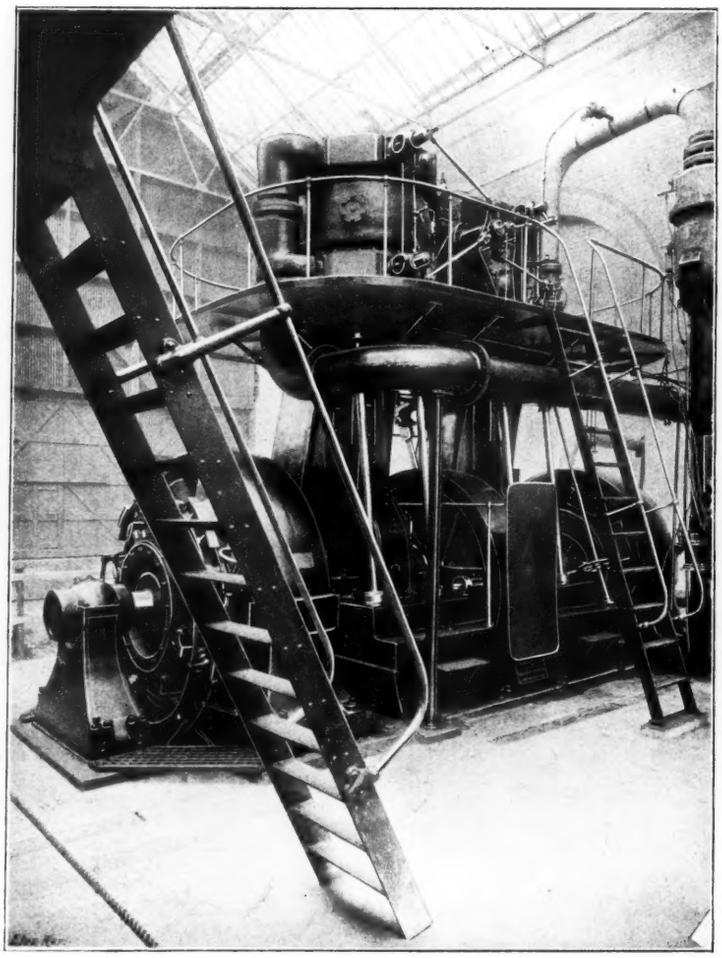
The present capacity of the coal store is about 4,000 tons, while an auxiliary open store holds about 2,000 tons in addition. Traps are provided in the roof of the store house, on both sides, through which coal can be raised by the transporter and transferred to the feed tanks, and at the bottom of the store, next the boiler house, doors are fitted in the wall to enable the coal to be delivered on the stoking floor.

The boilers and mechanical chain grate stokers are all of Messrs. Babcock & Wilcox's manufacture; 10 are at present installed, forming the full complement of the centre portion of the station. Each boiler is nominally of 1,100 H.P., with a heating surface of 4,020 square feet, and works at a pressure of 200 lbs. per square inch. The boilers are all fitted with superheaters, which are in regular use; owing to the high temperature corresponding to the pressure, *i.e.*, 385° F., it is not regarded as advisable to superheat more than about 20° F., the temperature at the stop valves of the engines being kept at about 405° F.

Beneath the stoking floor there is a tunnel provided with a railway, along which runs a wagon for the removal of ashes.



Belliss & Morcom Engine and British Thomson-Houston Dynamo.



Ball & Wood Engine and Walker Dynamos.

The automatic stokers are driven by two Byng-Hawkins enclosed motors, made by the General Electric Company, Limited, London; each of these is of about 15 H.P., running at 570 revolutions per minute, and taking 18 amperes at 500 volts. The motors are belted to a countershaft, which is divided into two portions by a clutch coupling, so that either motor may be used to drive the whole of the stokers, or may be run separately.

The safety valves are of Messrs. Turnbull's make, the boiler mountings by Messrs. Hopkinson. Some of the steam valves were supplied by Messrs. Templer & Ranoe, and some by Messrs. Schäffer & Budenberg, and Messrs. Stewart and Menzies carried out the steam piping. One of our views shows the top of the battery of boilers from one end; on this may be seen the superheater connections, the "explosion" valve near the commencement of each 8-inch branch, and the large expansion bend in the middle of the latter. Arriving at the wall next the engine house, each pipe is teed into a vertical pipe, one end of which goes down to the engines, and the other up to the 15-inch main steam range. At each tee there are three stop valves, so that each engine may be fed either by a separate boiler or from the main, or may be cut off entirely.

The "explosion" valves are of very simple construction, and completely close the steam passage in the event of a rush of steam occurring in either direction. They are of Messrs. Schäffer and Budenberg's make.

Care has been taken to provide easy access to all parts by means of galleries along the front of the boilers and of the coal tanks, over the boilers, and along the engine house wall under the steam pipes. There is also a gangway extending

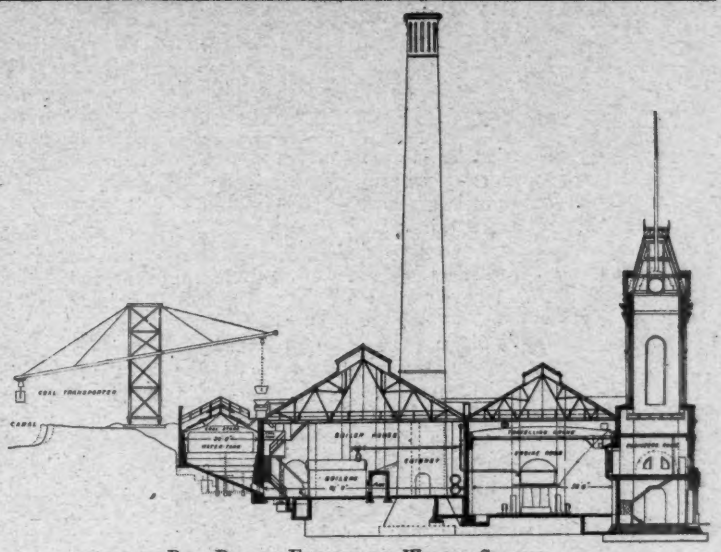
from the Temperley transporter through the boiler and engine houses at the level of the eaves to the engineer's rooms at the front of the buildings.

The whole of the boiler house walls are faced with white enamelled brick, and the whole of the roof is constructed of glass and iron, giving the best possible illumination to the interior. At night arc lamps are used for lighting.

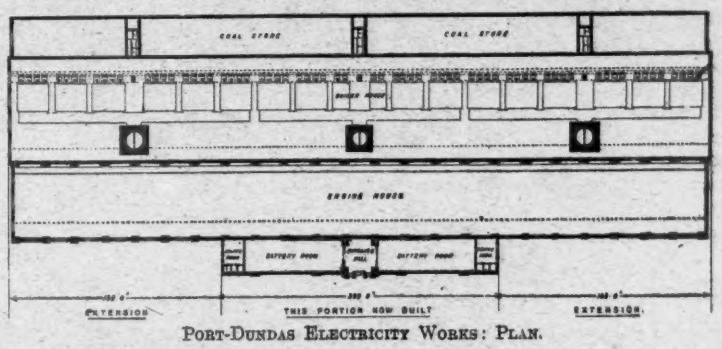
No economiser is provided, but provision is made for installing one at a future date if necessary. At present the flue gases are led direct to the chimney, which is about 200 feet high and 11 feet in diameter, standing on a square base.

The supply of make-up feedwater for the boilers is derived from the town mains, and, coming from Loch Katrine, is of the very purest and softest quality. There are two routes by which it is obtained, one from either end of the building; it is stored in a large tank in the coal store, capable of holding 15,600 gallons, whence it flows by gravitation into the hot well as wanted. All clean water drains are also brought direct to the hot well, but condensed water from the engines is pumped into a tank, from which it gravitates through a set of filters to the hot well.

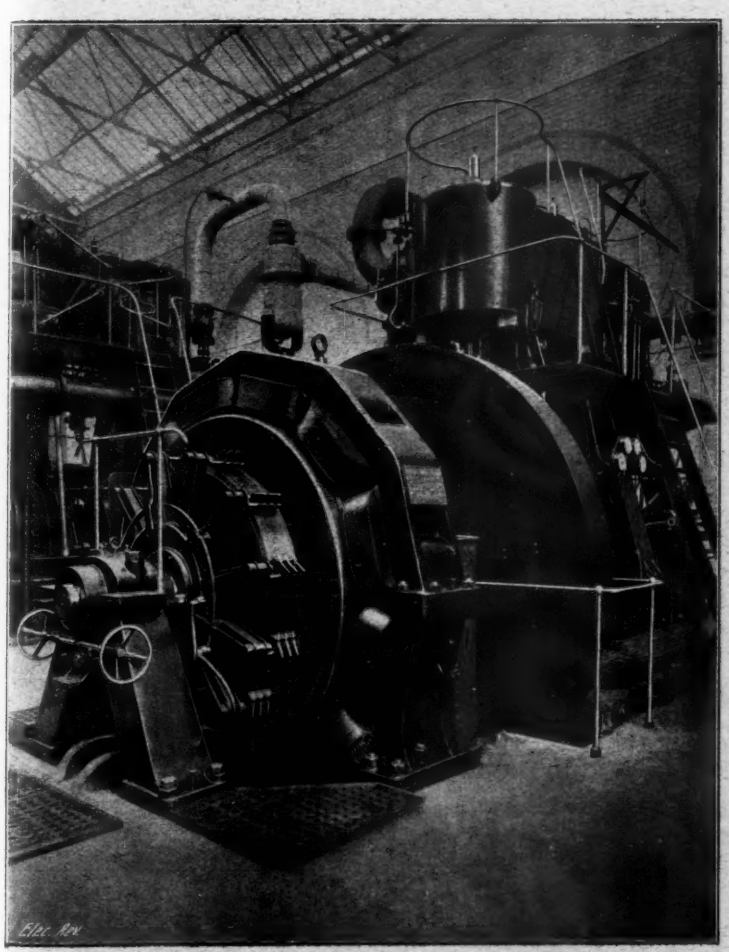
There are two double steam-driven feed pumps, and one single one, supplied by Messrs. J. & G. Weir, of Cathcart; the double pumps are fitted with heat economisers, and feed into either of the two feed-water ranges. Each is capable of delivering 4,000 gallons of water per



Port-Dundas Electricity Works: Section.




Port-Dundas Electricity Works: Plan.



Paul Engine and Schuckert Dynamo.

hour at normal speed. The single pump feeds into only one range, and a three-throw ram pump, by Messrs. Wimshurst, Hollick & Co., driven by an electro-motor, is connected with the other. All these pumps are situated at the middle of the range of boilers, together with the hot well and oil filters.

All hot pipes, both in the engine room and the boiler house, are lagged with magnesia sectional covering.

Two heavy 21-inch mains pass through the boiler house, conveying water for condensing from one point of the canal to the station, and returning it at another place.

We now pass on to the engine room. This is situated at a lower level than the boiler house, there being a drop of 7 feet 6 inches. Here, also, the walls are white and the roof glazed, while the floor is covered with polished "Terrazzo," giving a very handsome and clean appearance, and setting off the machinery to the best advantage.

Owing to the extreme haste with which the plant was got together, the engines and dynamos are of very varied types and sizes; it must be admitted that in this case this was not a fault, but rather a misfortune. Nevertheless, no ill effects seem to have ensued from the heterogeneous character of the plant, the whole of which is in first-rate order.

Each engine is supplied by a single steam pipe, provided with a separator close to the steam valve, and, with one exception, each exhausts into a separate surface condenser; a branch is taken from the exhaust pipe, through a Blake and

Beneath the stoking floor there is a tunnel provided with a railway, along which runs a wagon for the removal of ashes.

of the coal tanks, over the boilers, and along the engine house wall under the steam pipes. There is also a gangway extending



Knowles automatic valve, up the wall inside the boiler house to the atmosphere.

Starting from the north end of the station, the remote end in our general view, the first set consists of two Walker dynamos, coupled to a Ball & Wood engine; one of our illustrations shows the principal features of the set. The engine is of the vertical cross-compound description, with Corliss valve gear. Both cylinders are jacketted with live steam, and there is a reheater coil fed with live steam in the receiver, which is fixed between the cylinders. The admission valve gear of both cylinders is driven by an eccentric controlled by a fly-wheel governor, mounted on the shaft between the cranks; the exhaust valves are similarly actuated by a single eccentric. Provision for adjustment is made in the connecting rods between the wrist plates and the valve spindles. The cylinders are 20 and 44 inches in diameter, with a stroke of 24 inches, and the speed is 150 revolutions per minute. A Holden & Brooke separator is fixed close to the stop valve, and supported by a column of massive proportions to resist vibration.

The two Walker generators are coupled to either end of the main shaft, standing on separate bedplates; they were designed for the Walker Company by Mr. S. H. Short, who is now building similar machines at the English Electric Manufacturing Company's works, Preston. Each dynamo has eight poles, and gives out 1,200 amperes at 260 volts, but has often been loaded much beyond this without injury. The combination is available for use as a balancer. The magnet frames are of special cast-iron, into which the wrought-iron magnet cores are bedded in the operation of casting. The armatures are of the toothed-core, barrel-wound type, with massive commutators. The field magnets are provided with series winding for compounding, if necessary, but this is not used for the lighting load; the same applies to almost all the generators.

The condenser is placed above ground by the side of the engine, it being considered, with good reason, that "out of sight is out of mind." As there are two small condensing sets and three large ones, all made by Messrs. W. H. Allen and Co., of Bedford, a detailed description of one of the larger sets will suffice, in connection with the corresponding generating set.

The next set consists of a vertical engine made by Messrs. Matthew Paul & Co., Limited, Dumbarton, coupled to a Schuckert multipolar generator. The engine is of the marine triple-expansion three-crank marine type, having cylinders 17, 25½ and 38 inches in diameter, with a stroke of 30 inches, running at 120 revolutions per minute, and developing 900 I.H.P. at full load. In this case the condensing plant is self-contained, and the pumps are driven by levers and links from the cross-head of the middle piston rod. The air pump is of the Edwards patent type.

The speed of the engine is controlled by a throttle valve governor, the gear for which is driven by a sprocket wheel and chain from the engine shaft. A bye-pass enables steam to be admitted to the receivers, to start the engine from any position, and to afford additional power in case of an overload. Metallic packing of the "United States" type is used for the piston rods, and answers well. The high pressure cylinder is controlled by a piston valve, the others by flat valves, all worked by single eccentrics. This engine, as well as several of the others, is fitted with Grandison's sight-feed cylinder lubricators.

The generator is of the standard Schuckert 12-polar type, with an output of 950 amperes at 600 volts, and is shunt-wound only. The armature is similar in design to those of the Walker machines, but the magnet cores are cast with the yokes, and the brush rocker is carried by the bearing, with the adjustment gear brought through the pedestal.

Next come two engines by Messrs. Mirrlees, Watson and Yaryan Co., Limited, coupled to Crompton dynamos. The engines are of the single-acting type, with "splash" lubrication, and the steam is controlled by piston valves between the cylinders. The engine nearest to the Paul-Schuckert set is compound, rated at 200 H.P., and running at 375 revolutions per minute; the corresponding dynamo is of Messrs. Crompton's ordinary two-pole type, with an output of 250 amperes at 600 volts.

The other set consists of a triple-expansion 400 H.P. engine with four cylinders, two of them low pressure. The dynamo is rated at 500 amperes, 600 volts, at 375 revolutions per minute. The engines are controlled by throttle governors driven direct from the shaft, and capable of adjustment while running. Both engines exhaust into one Allen condenser.

Passing by the boosters and balancers for the present, we come now to two Belliss & Morcom engines coupled to British Thomson-Houston dynamos. Each engine is of the triple-expansion three-crank type, with one high, two intermediate, and three low pressure cylinders, and is rated at 1,100 I.H.P. normal, 1,500 I.H.P. maximum load, at 230 revolutions per minute. The generators are 12-polar, and compound wound to give 510 volts at no load, 600 volts at full load, with a rated output of 725 KW. The series winding is not at present in use. The machines are of the standard Thomson-Houston construction, with ventilated drum-wound toothed-core armatures. The commutator is mounted on an iron shell pressed on an extension of the armature spider. The magnet frame is of cast-steel, and the pole-pieces of mild steel.

A bye-pass throttle-valve is provided for admitting high pressure steam to the intermediate cylinders, to enable the engine to cope with a heavy overload; this is automatically controlled by the governor.

Each of these engines exhausts into a separate condenser, made by Messrs. W. H. Allen & Co., Bedford, and capable of dealing with 27,000 lbs. of steam per hour.

*(To be continued.)*

## THE GLASGOW CORPORATION ELECTRICITY WORKS.

On Thursday last week the two large electricity works which are being erected at Port Dundas and Pollokshaws Road were formally inaugurated by the Corporation of Glasgow. A large company of members and guests assembled at the City Chambers at 11 o'clock, where they were received by the Lord Provost and Bailie Maclay, convener of the Electricity Committee; the party then drove to Port-Dundas, where Bailie Maclay briefly outlined the undertaking, and the Lord Provost opened the station with a gold key, presented by Mr. Porter, the contractor for the brickwork.

The company proceeded to inspect the machinery in the engine and boiler houses, and afterwards drove to the St. Andrew's Cross Works in Pollokshaws Road; Bailie Maclay explained the work which was in progress, and was presented by Mr. Green, the contractor, with a gold key. Mr. Callender, for the cable contractors, presented a piece of silver plate to Bailie Willock, convener of the Sub-committee on Works, after which Bailie Maclay declared the station open. The party made the tour of the works, and then returned to the City Chambers, where luncheon was served.

After the Lord Provost had toasted "The Queen," Bailie Anderson proposed "The Houses of Parliament," hoping that in making the new House of Commons they would be "as fairly successful as the electors had been in former days."

Lord Overtoun replied for the Lords, and made a eulogistic reference to Lord Kelvin and his work. Sir Charles Cameron, M.P., responding for the Commons, said that henceforth he expected Glasgow to be at the head of all cities in the production of electricity.

The Lord Provost then proposed "The Electricity Committee, and Prosperity to the Undertaking." Bailie Maclay, replying, stated that the Committee had spent about three-quarters of a million, and would spend more if they had the opportunity; they had 13,000 H.P. at work, and additional plant on order.

After Bailie Maclay had toasted "Our Guests," for whom Sheriff Strachan replied, Bailie Willock proposed "The Engineer and Architect," and remarked on the absolutely unanimous selection of Mr. Chamen for the post of electrical engineer. In reply, Mr. Chamen expressed his personal thanks to the architect, Mr. Myles, who had assisted him in every possible way. Mr. Chamen also paid a warm tribute to his staff, referring to the perfect harmony that reigned between them.

PAUL ENGINE AND SCHUCKERT DYNAMO.

the exhaust pipe, through a Blake and



Councillor Finlay then proposed "The Contractors," for whom Mr. J. Porter replied, and the proceedings came to an end with the toast of the "Lord Provost," proposed by Mr. C. Corbett, M.P., and duly honoured.

## CONTRACTS OPEN AND CLOSED.

(*Continued from page* 464.)

**Whitehaven.**—October 13th. Tenders are wanted for the supply and erection of a switchboard at their electric lighting station. See "Official Notices" September 14th.

**Wigan.** — September 27th. The Corporation wants tenders for poles, pillars, bonds, trolley wire, overhead material, bracket arms and castings for the equipment of electric tramways. See "Official Notices" to-day.

### CLOSED.

**Aberdeen.**—Messrs. MacArtney, McElroy & Co., of London, have secured the contract for steel poles, bases, and brackets, for the Tramways Committee.

**Cardiff.**—Messrs. W. Lace & Sons, of Cardiff, have secured a contract for sundry piping (costing £1,300) for the Corporation electricity works.

**London.**—The Hart Accumulator Company, Limited, have secured the contract for the supply of the storage battery required by the Committee of Management of the Kensington and Notting Hill Electric Lighting for use in the lighting of their Wood Lane works.

**Newcastle-on-Tyne.**—Messrs. Mather & Platt are to supply pumping plant for the Corporation tramway power generating station at £1,470. Contracts have been given out for preparation of the electrical tramways as follows:—Mr. E. Nuttall (eastern section), at £26,070; Mr. J. Robson (western section), at £24,500.

**Portsmouth.**—The Tramways Committee received the following tenders for the equipment of the power station, viz., Combe, Barbour & Combe, £27,137 12s. 6d.; British Schuckert Company, £29,130; Brush Electrical Engineering Company, £29,351 10s.; British Westinghouse Company, £29,390; R. W. Blackwell & Co., £29,568 17s.; Dick, Kerr & Co., £29,656; Siemens Bros. & Co., £29,858; Electric Construction Company, £30,262. These tenders were referred to a sub-committee. What has happened since will be ascertained from the following taken from the *Portsmouth Times* of 15th inst. We print the proceedings at length in view of their great interest. The sub-committee reported that having carefully gone through all the tenders received, they found there were only three firms who would complete the work in less than 12 months, *i.e.*, before next summer, viz.:—Messrs. R. W. Blackwell & Co., Messrs. Dick, Kerr & Co., and the Electric Construction Company. The first-named firm would complete the work in eight months, while Messrs. Dick, Kerr & Co. would undertake to run one or two engine sets in six or seven months, and complete the whole in nine months. Messrs. Dick, Kerr & Co.'s tender provides for British-made stuff throughout, and the whole of the apparatus is entirely in accordance with the specification. This tender is also superior to Messrs. Blackwell & Co.'s in other respects, notably with regard to the pipe work, and in consideration of the foregoing grounds, they recommended that the tender of Messrs. Dick, Kerr & Co. for £29,656 be accepted. The Committee also submitted tenders for the erection of the power station buildings and chimney in Vivash Road, and recommended that the tender of Mr. J. W. Perkins, being the lowest, be accepted, the amount being £10,515 8s. In doing so, Mr. Kimber said that they were of opinion that the power station should be put up as soon as possible, for it was impossible to work any section without it. They wanted to get part of their section working before the summer, and their engineer believed that was feasible. He hoped that they would take some definite action that day, because if they did not they would lose their summer traffic. All the firms were people of the highest repute, and they could depend upon the work being done satisfactorily. He might say that since the tenders had been opened, one firm had sent a letter amending their terms, and he did not know if the Council would like him to read this.

Mr. Duck seconded the motion.

Mr. Amatt remarked on the fact that the tender of Messrs. Combe, Barbour & Combe was £2,500 below that of Dick, Kerr and Co., and he thought the letter from them should be read.

Mr. Dummer strongly protested against such a course being taken, and Mr F. G. Foster concurred.

Mr. Carpenter said that a difference of £2,500 was considerable. He believed their engineer was formerly in the employ of Dick, Kerr & Co., and they could not help people talking, while he was told that the engines of Messrs. Combe, Barbour & Combe were superior to those offered by Dick, Kerr & Co. When they wanted to lay down their tramlines they would desire to have the work done as speedily as possible, and if contractors thought there was a private arrangement, and that it was no good tendering, Dick, Kerr & Co. would get all the work, and they would lose more than £2,500.

Mr. Stevenson said the reason Dick, Kerr & Co. were selected was because their tender for the engines was the only one that complied exactly with the requirements of the committee.

Alderman Ellis said he was entirely opposed to the opening of what was practically an amended tender; Messrs. Combe, Barbour and Combe had had no experience in making these engines, while undoubtedly Dick, Kerr & Co. had made the best tramways in England, and they had chosen a firm to make the engines who had done satisfactory work for them in the past. He hoped they would carry the resolution, and at any rate he was going to support it.

Alderman Scott Foster took the same view, and said that if they allowed anyone to send in a tender after the others submitted had been opened and dealt with, they would be acting in bad faith with other firms.

Mr. Evans said the engineer told them that the engines supplied by Dick, Kerr & Co. were 12 per cent. better than those of Combe, Barbour & Combe, while they would do the work three months earlier, and these were the reasons that they recommended the acceptance of the tender of the former. He was, however, of opinion that the letter should be read.

Mr. Dittman thought that under no consideration could they look into an amended tender, and the public would be well served if they voted for Dick, Kerr & Co.'s tender.

Mr. Corke said he thought it was a very dangerous thing to receive a tender after the time advertised. The committee were somewhat excused by the fact that the Belfast firm (Combe, Barbour and Combe) telegraphed to them, saying that the tender was coming, and they adjourned the opening of the others accordingly. They should either accept the tender proposed by the committee or the next one.

Mr. Murtough supported the action of the committee, and thought they would act very unwisely in opening the letter.

Mr. Kimber thought Mr. Carpenter had been very unfair, for he had perfect confidence in their engineer.

The resolution was then put and carried.

**Salford.**—The *Salford Reporter* of September 8th stated that at a recent Council meeting Alderman Shaw moved the acceptance of the tender of Messrs. W. T. Glover & Co., Limited, for supplying, delivering, and laying the lighting cables, tramway feeders and street lighting accessories for the sum of £159,648 12s. 8d. This was the lowest tender which conformed to the specification, and the cable would be subjected to the test mentioned in the specification before it was taken over. The consulting engineers would see the cables tested. Councillor Higson said there was one tender lower than Glover's, but the reason it was not accepted was because they proposed to substitute tar in place of a bituminous compound. The British Insulated Wire Company, of Prescot, were £650 below, but they did not conform to the specifications. He congratulated the Council and Messrs. Glover that they had a firm within the boundaries of the borough capable of undertaking the work.—Councillor Hailwood asked what the time limit was for the completion of the contract?—Alderman Shaw: Before we are ready.—The Mayor said he was pleased to find that there were local firms capable of doing the work they required. He had heard it said that directly they had some money to spend, they spent it a considerable distance from their own town. The local firms, such as Mather & Platt, Galloways, and one or two others, could do their work, and it was pleasant to think that they were practically employing their own people. The resolution was carried.

**Southampton.**—The Guardians received the following tenders for an electric installation at the new Workhouse Infirmary:—

| | |
|---|---|
| National Electric Light Company .. .. .. | £4,890 0 0 |
| Maple & Co. .. .. .. .. .. .. .. | 5,494 5 6 |
| Putton & Sull .. .. .. .. .. .. .. | 4,056 0 0 |
| Gifkins & Co. .. .. .. .. .. .. .. | 5,465 0 0 |
| F. Troy & Co. .. .. .. .. .. .. .. | 4,825 0 0 |
| Lankester & Son .. .. .. .. .. .. | 3,499 10 0 |
| Shalders & Davis .. .. .. .. .. .. | 4,100 0 0 |
| Crompton & Co. .. .. .. .. .. .. | 4,950 0 0 |
| Cox, Walker & Co. .. .. .. .. .. .. | 4,254 0 0 |
| Thomas & White .. .. .. .. .. .. | 5,406 2 6 |
| Drake & Gorham .. .. .. .. .. .. | 4,058 0 0 |

The tender of Messrs. Lankester & Son was accepted.

**Southend-on-Sea.**—Messrs. Lowden Brothers & Co. have secured the contract for the ten miles of overhead equipment for the light electric railway at Southend-on-Sea. The whole of the material will be manufactured at Dundee. They have also received orders for trolley standards of their own patent design from a number of Corporations, including Manchester, Sheffield, Leeds and Bradford.

**Tunbridge Wells.**—The *Contract Journal* gives the following list of tenders accepted by the Council for carrying out the telephone installation for the Town Council. Accepted tenders:—Henley's Telegraph Works Company, supplying, laying, and jointing of armoured telephone cables, £2,373 10s.; Reid Bros., erecting and staying poles, wires, arms, insulators, &c., £1,080; General Electric Company, telephone instruments, £843; Wade and Co., creosoted poles, £702 2s. 3d.; Bolton & Sons, hard copper wire, £518 2s. 1d.; Telegraph Manufacturing Company, switchboard, £282 15s. 6d., insulated wires, £218 10s.; General Electric Company, insulators, £216 19s. 8d.; International Electric Company, lightning arresters and high tension guards, £102 1s.; Bullers, Limited, miscellaneous ironwork, £97 2s. 2d.; Aspden & Co., oak arms, £64 1s. 2d.; Dennis & Co., iron and steel stay wire, £37 15s.; India-rubber, Gutta-Percha, and Telegraph Works Company, batteries, £35 5s.; Bolton & Sons, soft copper wire, £21 11s. 8d.; Potter & Co., arm bolts, nuts and washers, £10.

**Walsall.**—The Town Council has accepted the tender of the Electrical Power Storage Company for a battery for the proposed extension to the Pleck, at £679.

## FORTHCOMING EVENT.

Monday, October 1st.—At 7.30 p.m. Society of Engineers. Meeting to be held at the Royal United Service Institution, Whitehall, where a paper is to be read on "Paper-Making Machinery," by Mr. R. Henderson.

## NOTES.

**Corporation Energy for Driving Dynamos.**—A correspondent writes as follows :—"I should be pleased to have your opinion on the following : In the rules regarding the supply of current from Corporation mains to consumers, it is stated that current shall be paid for for lighting purposes at, say, a rate of 4d. per unit, and for power at 2d. per unit. Supposing a consumer to have a motor working in his premises off the supply mains and to pay at the rate of 2d. per unit, and he puts down a dynamo to supply current to a number of lamps, what objection can be raised by the Corporation to his driving the dynamo by the said motor, which is, really, obtaining his lighting at 2d. per unit plus the cost of machine and machine losses?" It seems perfectly clear to us that there is nothing to prevent the use of electrical energy supplied at the "power" rates for driving a dynamo. He employs it as a motive power for driving a machine. The purpose for which he drives that machine is no concern of the Corporation or company from which he takes his electrical energy.

**The Copper Market.**—The last issue of Messrs. H. R. Merton & Co.'s statistical circular shows that stocks have fallen by 1,040 tons during the first half of the month, this fall being chiefly due to a diminution in the shipments from North America. In place of 6,500 tons, the average for the preceding 12 months, only 4,146 tons has been received from this source of supply, and total supplies have thus reached only 9,257 tons as compared with deliveries equal to 10,297 tons. The following figures show the relation between the supplies from N. America and the total supply during the last seven months :—

| Month. | Supplies from N. America. | Total supplies. |
|---|---|---|
| February, 1900 ... ... | 13,027 ... | 23,272 |
| March, 1900 ... ... | 15,147 ... | 25,421 |
| April, 1900 ... ... ... | 18,289 ... | 27,155 |
| May, 1900 ... ... ... | 13,431 ... | 25,240 |
| June, 1900 ... ... ... | 17,886 ... | 26,870 |
| July, 1900 ... ... ... | 12,054 ... | 21,226 |
| August, 1900... ... ... | 16,845 ... | 26,940 |
| September, 1900 (first half) | 4,146 ... | 9,257 |

The prices of G.M.B.'s during September have fluctuated in sympathy with the movement in stocks, having risen from £73 on August 31st to £73 12s. 6d. on September 15th.

**Forthcoming Lectures.**—At the Technical College, Finsbury, the evening courses begin on Monday, October 1st. Prof. Silvanus Thompson opens the Monday evening (advanced) course with an introductory lecture on "The Distribution of Electricity," the succeeding Monday evenings until Christmas being devoted principally to the subject of "The Design of Continuous Current Dynamos and Motors." On Wednesday evenings Dr. E. W. Marchant will lecture on "Electric Currents and Methods of Measurement;" Prof. Thompson will also give a short course of special lectures on Fridays on "The Polarisation of Light."

**Personal.**—Mr. L. B. Stillwell has resigned as electrical director of the Niagara Falls Power Company, and Mr. Harold Winthrop Buck has been appointed to the position. Those who recall Mr. Stillwell's extended connection with the Niagara power development will look upon this change with surprise. Ever since the Niagara development was projected, Mr. Stillwell has had to do with the plans. While electrical engineer and assistant manager of the Westinghouse Electric and Manufacturing Company, all the electrical apparatus now in use in the present central station was built by that company under his supervision, and since March, 1897, he has had charge of, and has directed the installation as electrical director. Of Mr. Stillwell's future plans it is announced that he will go to New York city and there open an office as consulting electrical engineer, a field to which for the past two years he has devoted much of his attention, notably in the equipment of the elevated railways of the Manhattan Railway Company, which is now proceeding under his direction. Mr. Harold Winthrop Buck, the gentleman who succeeds Mr. Stillwell, has been for the past five years or so in the employ of the General Electric Company at Schenectady, N.Y. Other changes announced by the Niagara Falls Power Company are that assistant superintendents Paul M. Lincoln and Philip P. Barton have been promoted, the former to be resident electrician, and the latter to be superintendent of the operating department.

The Admiralty has created an important new post in the Dockyard staff, namely, that of electrical engineer, to rank next to the four chief assistant engineers. To fill this post, the Admiralty has chosen Mr. Louis J. Steele, M.I.E.E., late chief engineer of Messrs. Veritys, and formerly assistant engineer with Messrs. Johnson & Phillips. Mr. Steele received his training at the Technical College, Finsbury, under Prof. Silvanus Thompson and Prof. Perry, and carried off the certificate of the college in 1890. He will be attached to the Dockyard staff at Portsmouth.

Mr. H. T. Tacey informs us that he is no longer lecturer on electricity at the Bradford Technical College.

The Gas and Electric Lighting Committee of Aberdeen Town Council agreed last week to increase the salary of Mr. J. Bell, the electrical engineer, by the amount of £50 per annum, by annual increments, until it reaches £500. The present salary is £300.

Mr. H. W. Angus, who for some years has held the position of chief assistant at the Bolton Corporation electricity works, has resigned that office upon his appointment as borough electrical engineer at Eccles. Mr. A. A. Day, the newly-elected borough electrical engineer for Bolton, will take up duty on the 24th inst.

The British Thomson-Houston Company, of London, have appointed Mr. T. W. Sheffield as district manager of the branch depôt which they have recently opened at Trevelyan Buildings, Corporation Street, Manchester, for the sale of electrical apparatus and general supplies.

**Fatality.**—While engaged upon some electrical work at the Wyken Colliery, near Coventry, on 17th inst., a man named Ward received a fatal shock from an electric motor. At the inquest on Wednesday it transpired that deceased was a miner, but was more or less familiar with the electric fittings of the mine. The motor was a 2½ H.P. (450 volts), and was employed for ventilation purposes. Evidence was given by the electrical staff which showed that the motor was at the time being repaired in some minor details, with, it was supposed, the current turned off. While tightening some pins, deceased somehow or other fell across the motor with his breast on the terminals. He received the 450 volts through his body, the current having somehow or other got switched on—it was suggested by Ward's body. The Coroner summing up said it was remarkable that a current of 450 volts should kill the deceased ; there must have been some idiosyncracy in his constitution. It was clearly the neglect to see the switches properly cut off, either at the stall head or at the motor, that brought about the unfortunate accident. If anybody had been there who well understood the Marshall Hall method of respiration, deceased might have been saved. A verdict of "Accidental death" was returned.

**Postmaster-General's Annual Report.**—The Annual Report of the Postmaster-General, which has recently been issued, states that the number of telegrams sent over the wires of the department was 90,415,123, the increase being 3·87 per cent. The increase in the number of ordinary inland telegrams was 2·88 per cent., as compared with 4·95 per cent. for the previous year, and the increase in revenue was 3·74 per cent., the average value of these telegrams having risen from 7·38d. to 7·44d. The number of foreign telegrams, 7,521,540, is the highest on record, being 7·83 per cent. in excess of the number for the previous year. The growth is chiefly attributable to activity in Stock Exchange business and to the war in South Africa. The increase in London local telegrams was 1·35 per cent., the number being 7,941,540, as compared with 7,827,576 ; these telegrams have not increased at the same rate as the general traffic, due no doubt to the competition of the telephone and express messenger services. During the year 372 new telegraph offices were opened, of which 17 were at railway stations. The total number of telegraph offices is now 11,188. The number of post offices open for trunk telephone business on March 31st last was 299, an increase of 13 in the year. The trunk lines in use consisted of approximately 68,657 miles of wire, and 7,250 miles of wire were in course of erection. Out of the sum of £2,300,000 authorised by Parliament for the purchase and development of the trunk system, the expenditure up to March 31st may be stated approximately as £1,531,209. The expenditure during the year was approximately £176,968. The total number of trunk wire transactions during the year was 8,094,578, or, reckoning each transaction as involving at least two spoken messages, a total number of 16,189,156, an increase of 14·55 per cent. over that of the preceding year. The revenue was £191,701, an increase of 14·44 per cent., and the average value of each transaction was the same as in the preceding year—namely, 5·68d. The Post Office telephone and private wire system show a general increase, the revenue for the year from this source being £148,200, as against £142,600 in the previous year. The telegraph revenue, £3,460,492, shows an increase of £200,347, and the telegraph expenditure £3,748,930, an increase of £266,916. The net deficit on telegraphs was thus £288,438, or £66,569 more than last year. If allowance be made for interest on the capital—£10,868,663—created for the purchase of the telegraphs, the deficit on the year is raised to £587,326.

---

**Obituary.**—We regret having to record the death on September 12th of Mr. John Robert Jefferies, of the well-known firm of Ransomes, Sims & Jefferies, Limited, of Ipswich.

The death is announced of Alderman Mander, of Wolverhampton. Among other positions filled by the late Alderman was that of the chairmanship of Messrs. T. Parker, Limited.

The death is announced in Sydney of Col. P. B. Walker, chief electrician and engineer-in-chief of the telegraphs of New South Wales. The deceased, who was 60 years old, and who had been 42 years in the civil service, died somewhat unexpectedly, asthma being the immediate cause.

---

**Appointments Vacant.**—The Nottingham Corporation is wanting an outdoor superintendent to take charge of the construction of permanent way for electric tramways. He will act under the direction of the city engineer, with 800 men under his control, and the salary is put at £300. Applications have to be made to the city engineer by September 29th.

The Royton Urban District Council invites applications from engineers capable of assisting it in the preparation and carrying out of an electric light and tramway scheme. See "Official Notices" to-day.

A resident electrical engineer is wanted by the Bermondsey Vestry at £250 per annum. See "Official Notices" to-day.

**University College Lectures.**—We have pleasure in directing attention to classes and courses of lectures which have been arranged at the University College, London, in conjunction with the Technical Education Board of the London County Council, at reduced fees. Evening science classes will be given in electrical engineering, there being a course of 10 lectures by Prof. J. A. Fleming, followed by laboratory practice in advanced electrical measurements. These will be delivered on Wednesdays, from October 17th to December 19th, and the fee will be only 5s. There will also be a course of lectures on "The Electric Motor and its Applications in Electric Traction," by Prof. C. A. Carus-Wilson, M.A. These will be delivered on successive Wednesdays, from January 23rd to March 20th, 1901, and the fee for the course will be only 5s. Among the other lectures coming under this arrangement will be a course of Friday evening lectures (10) on the theory of steam engines and boilers, with laboratory work, the testing, &c.; five Friday lectures on the theory of gas and oil engines, all by Prof. T. Hudson Beare; Mr. Leslie Robertson will give a course of five lectures on "Water-Tube Boilers" in March next; Prof. Capper gives a course of about 20 demonstrations on Thursdays, commencing October 10th, on steam and gas engines and general laboratory work. The electrical engineering lectures are for the benefit of those practically engaged during the day in some branch of the electrical industry, and we have no doubt that they will be largely taken advantage of.

---

**Battery Traction.**—Recent events in the direction of electric traction by accumulators must have been discouraging to workers in this interesting field. The decision of the Chicago and Englewood Company to remove battery traction from its 30-mile system and substitute the overhead trolley, and that of the Birmingham Tramway Company to do the same in regard to the Bristol Road battery section, are now followed by the announcement that the accumulator is to be gradually abandoned as regards the Berlin tramways, the overhead trolley taking its place in some roads and the conduit in others. The matter is stated as follows in the *Financial Times*:—

As a consequence of many interruptions in the service and of accidents on those sections of the Berlin tramways worked by means of accumulator cars, the German Ministry of Public Works recently appointed a technical commission to investigate the question of the suitability of these storage battery cars for the heavy traffic prevailing in that city. The unanimous report of the Commission, which has just been issued, states that accumulator traction still exhibits great imperfections, and that it requires serious deliberation, both in regard to security of working and safety of the public. As far as the exercise of tractive force is concerned, the method is far behind the overhead trolley or the underground conduit system. The charging of the batteries has to be too frequently performed, and, if charged from overhead trolley wires, the method also has considerable technical difficulties. The report submits that the batteries are so heavy as to undesirably increase the weight of the tramcars, with the result that, apart from the excessive wear of the rolling stock, the car bodies are frequently damaged, and lead to interruptions in the traffic. The accumulators are dangerous from a fire standpoint, and in winter time, when the cars are closed, the development of acid fumes is not only oppressive to passengers, but also dangerous to health. On these grounds the Commission concludes that storage battery cars are not yet suitable for the heavy street traffic of Berlin. As a result, it has been decided by Imperial authority to gradually abandon the use of accumulator cars on the Berlin tramways, and to substitute the overhead trolley system, except in special busy sections, where the underground conduit method will be introduced.

---

**International Tramway Congress, Paris.**—Many interesting discussions were carried on during the above Congress, especially on matters relating to electric traction. The British Isles was not strongly represented as to numbers, but the few who were there made their presence felt as to quality. Mr. R. H. Scotter, light railway engineer, of Westminster, spoke on the relation in England between light railways and the main lines, and showed in what particular light railways differed from tramways. He pointed out that the want of progress in tramways had been more the result of lack of opportunity, biassed by the purchase clause in the Tramway Act of 1870, than lack of enterprise. Rapid progress, however, had been made under the Light Railways Act of 1896. Mr. Scotter was the only Englishman who spoke at the Congress, and he was most enthusiastically received.

Thompson will also give a short course of special lectures on Fridays on "The Polarisation of Light."

Hall method of respiration, deceased might have been saved. A verdict of "Accidental death" was returned.



**Presentations.**—Mr. F. Kershaw, who has just ceased his connection with the City Electricity Works, Bradford, has been presented with a case of cutlery by the chief officials and staff. Mr. Kershaw is taking up a post as chief assistant to Mr. A. H. Gibbings, consulting electrical engineer.

In leaving the Liverpool University College for the principalship of the Birmingham University, Dr. Oliver Lodge has offered to present to the former a bronze bust of Mr. Wm. Rathbone, and the Council has gratefully accepted the offer.

As a memento of the first bestowal of the freedom of the Borough of Carnarvon on a true "hogyn o'r dre'," Sir W. H. Preece has presented a magnificent chair, said to be a fine work of art, to the Mayor and Corporation.

On Saturday last Mr. F. A. Wilkinson, borough electrical engineer, *pro. tem.*, presented Mr. W. Barnes, who for the past five years has filled the position of station electrician, with a silver watch (non-magnetic) and a meerschaum pipe on behalf of the employés of the Salford electricity works, as a token of respect before leaving for his new position in London.

---

**The B.A. Meeting for 1901.**—Next year's meeting will be held at Glasgow, commencing on September 11th with Prof. A. W. Rucker as president. The "Mechanical Science" Section (G) is in future to be known as the "Engineering" section. Next year will be the great International Exhibition year at Glasgow.

---

**Appointment.**—Mr. L. R. Wilberforce, M.A., Demonstrator of Physics at the Cavendish Laboratory, Cambridge, and University Lecturer in Physics, has been appointed to the Lyon Jones Chair of Experimental Physics at University College, Liverpool, vacated by the removal of Dr. Oliver Lodge to the University of Birmingham.

---

**Election Note.**—It is stated that Mr. F. Hastings Medhurst, M.I.E.E., will put up as Conservative and Unionist candidate for Islington in opposition to Mr. T. Lough, M.P., whose majority at the last election was only 463.

---

**Fire.**—A portion of the instrument room of the Manchester Head Post Office has been destroyed by fire, and telegraphic communication with that place temporarily interrupted. The fire broke out on Wednesday behind the test board, owing to the upsetting of a naptha lamp.

## NEW COMPANIES REGISTERED.

**Accumulator Industries, Limited** (67,180).—This company was registered on September 12th, with a capital of £10,000 in £1 shares, to adopt agreements (1) between H. Leitner, F. W. Manley (for the company), and B. Kuttner, and (2) between H. Leitner and F. W. Manley (for the company), to acquire certain benefits and inventions, and to carry on the business of electric accumulator, motor, controller, vehicle, and dynamo makers, engineers, tool makers, platers, founders, wire drawers, tube makers, &c. The first subscribers (each with one share) are:—H. W. Martin, 26, Stronghold Avenue, Streatham, S.W., clerk; C. Ayliffe, 20, Eccles Road, Clapham Common, S.W., clerk; D. D'A. Daunt, 34, Lambert Road, Brixton Hill, S.W., clerk; N. E. Ball, 55, Glycena Road, Lavender Hill, S.W., law clerk; H. C. Bevis, 12, Aldebert Terrace, Clapham Road, S.W., accountant; J. D. Hobson, 7, Duke Street, Adelphi, W.C., and D. R. Hobson, 7, Duke Street, Adelphi, W.C., architect. The number of directors is not to be less than two nor more than four; the first are H. Leitner and B. Kuttner; qualification, £100.

---

**Meyra Electric Company, Limited** (67,181).—This company was registered on September 12th, with a capital of £10,000 in £1 shares, to acquire a certain invention for improvements in galvanic batteries, with the trade mark "Meyra," and an invention or secret process for dry batteries, to adopt an agreement with P. Meyer, and to carry on the business of machine makers, electrical and general engineers, founders, tool makers, manufacturing chemists, &c. The first subscribers (each with one share) are:—G. T. B. Cobbett, Hamilton House, Bishopsgate Street Within, E.C., timber merchant; P. Meyer, 75, Newman Street, W., electrician; O. Kopp, 75, Newman Street, W., electrician; R. S. White, 94, Ridgmount Gardens, Gower Street, W.C., clerk; O. Percy, 58, Queen's Road, Leytonstone, manager; G. H. Homan, 2, White Hart Court, Bishopsgate Street, E.C., accountant; and S. Bridgewater, 78, York Road, King's Cross, N., engineer. The number of directors is not to be less than four nor more that seven; the first are G. T. P. Cobbett, O. Kopp, S. Bridgwater, and P. Meyer; remuneration £100 each per annum.

---

**Electro-Ceramic Syndicate, Limited** (67,172).—This company was registered on September 11th, with a capital of £2,000 in £1 shares, to acquire certain inventions relating to electro-ceramic photography, chinagraphy, and other manufactures and processes now known to and vested in or hereafter to be discovered or acquired by F. J. Shippey, or Messrs. Shippey Brothers, Limited, and to manufacture and deal in photographic china plaques, electro-ceramic china, electrical, photographic and other apparatus, &c. The first subscribers (each with one share) are:—A. R. Roberts, 63, Queen Victoria Street, E.C., solicitor; W. T. Smedley, 119, Ashley Gardens, S.W., chartered accountant; A. J. George, 33, Hatton Wall, E.C., manufacturer; T. Mason, 15, Chandon Road, Clapham, S.W., manager; A. P. M. Rivolta, 94, Camberwell New Road, S.E., accountant; A. Hamburger, 77, Avenue Road, N.W., consulting chemist; and A. Shippey, 13-14, King Street, E.C., electrician. The number of directors is not to be less than two nor more than four; the first are E. B. Koopman, W. T. Smedley, and A. Shippey.

---

**British Power, Traction and Lighting Company, Limited** (67,213)—This company was registered on September 15th, with a capital of £52,000 in £1 shares (50,000 preference), to acquire the businesses of the Engineer Cycle Works, Limited, the Eclipse Brass and Copper Company, Limited, the Anglo-American Motor Car Manufacturing Company, and the Power Transmission and Traction Company, all of Hull Road, York, to take over assets of the Disc Hub and Components Company, Limited (in liquidation), and to carry on the business of motor, motor car, crane, lift, and cycle manufacturers, cycle and motor accessory makers, machinists, gas, oil, electrical and general engineers, wire drawers, tube makers, platers, india-rubber merchants, tool makers, ironmongers, &c. The subscribers (each with one share) are:—Albert E. Hodgson, The Cedars, Haxby, York, engineer; George J. Gibbs, 76, Heslington Road, York, engineer; Charles Medgley, 4, St. Nicholas Villa, York, works manager; Alfred E. Miethe, 31, Belle Vue Street, York, clerk; William Peddie, 23, Chesham Street, Bradford, clerk; William H. Spencer, Primrose Cottage, Lee Mount, Halifax, worsted spinner; and M. Patchett, 16, Glen Terrace, Halifax, gentleman. The number of directors is not to be less than three nor more than seven; the first are to be appointed by the company; qualification, 500 shares.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Chili Telephone Company, Limited** (29,252).—This company's annual return was filed on August 31st, when 44,000 shares were taken up out of a nominal capital of £250,000 in 50,000 shares of £5 each. £5 has been called up on each share, resulting in the receipt of £220,000.

**Column Printing Telegraph Company, Limited** (29,493).—This company's annual return was filed on August 30th, when 289 shares were taken up out of a nominal capital of £25,000 in 500 shares of £50 each. £50 per share has been called up on 189 shares, resulting in the receipt of £8,940. £510 remain in arrears. 100 shares are considered as fully paid.

**British Electric Transformer Manufacturing Company, Limited** (57,293).—This company's annual return was filed on August 17th, when 20,000 vendors' and 20,000 ordinary shares were taken up out of a nominal capital of £50,000 in 20,000 vendors' and 30,000 ordinary shares of £1 each; £1 has been called up on each ordinary share, resulting in the receipt of £20,000, and the vendors' shares are considered as fully paid.

**Marconi International Marine Communication Company, Limited** (65,759).—This company's annual return was filed on August 22nd, when 204,000 shares were taken up out of a nominal capital of £350,000 in £1 shares; 5s. per share has been called up on 99,000, resulting in the receipt of £24,349; £401 remains in arrears; £105,000 is considered as paid on 105,000 shares.

**Sunbeam Lamp Company, Limited** (25,498).—This company's annual return was filed on September 1st, when 1,765 shares were taken up out of a nominal capital of £25,000 in 2,500 shares of £10 each; £10 per share has been called up on 908, resulting in the receipt of £9,080; and 857 are considered as fully paid.

Vestry at £250 per annum. See "Official Notices" to-day.

the Congress, and he was most enthusiastically received.



## SUPPLY STATION ACCOUNTS.

**Liverpool Corporation Electricity Accounts.**

The accounts for last year of the electricity supply department of the Liverpool Corporation show a remarkable development of the undertaking. The figures in the increase column of the general statement of the business below would alone be regarded as extremely satisfactory for a medium sized supply system, and these give an idea of the rapid growth that is taking place, fully warranting the promotions and increase enrolments of the staff just granted by the Corporation. Liverpool has always been noted for the unostentatious manner in which the electricity supply has been conducted. The latest addition, that of traction on a large scale, is making itself felt, and public lighting is gradually being extended. We imagine that Mr. A. Bromley Holmes can claim the credit of having been connected with one system as its designer and manager for a longer period than any other municipal engineer.

GENERAL STATEMENT.

| | 1898. | 1899. | Increase. |
|---|---|---|---|
| Total capital expenditure ... | £591,587 | **£769,589** | £178,002 |
| Number of units sold ... ... | 2,915,695 | **5,729,477** | 2,813,782 |
| Number of lamps connected ... | 158,269 | **237,952** | 79,683 |
| Maximum load in KW. ... ... | 3,633 | **5,160** | 1,527 |
| Gross revenue ... ... ... | £58,501 | **£73,504** | £15,003 |
| Gross expenditure ... ... | £28,900 | **£33,548** | £4,648 |
| Gross profit ... ... ... | £29,601 | **£39,956** | £10,355 |
| Average price per unit sold ... | 4·41d. | **2·89d.** | — 1·52d. |

The revenue account indicates the result of the reductions in price and the effect of the tramway load. Owing to the smaller charges for the public lighting, the revenue from this source has actually dropped as will be seen from the following summary:—

| Year. | From private supply. | From public lighting. | From traction. | Manufacturing account. Sales and repairs. | Manufacturing account. Wages and material. | Profit. |
|---|---|---|---|---|---|---|
| 1898 ... | £50,809 | £2,631 | £437 | £21,818 | £18,954 | £2,864 |
| 1899 ... | £59,713 | £1,925 | £7,362 | £19,501 | £17,432 | £2,069 |

Owing to the increase in output, the revenue per unit under each head has fallen on energy by over 1½d., and on the total receipts by nearly 1¾d.

REVENUE STATEMENT.

| | 1898. Gross. | 1898. Per unit. | 1899. Gross. | 1899. Per unit. | Increase. |
|---|---|---|---|---|---|
| Sale of energy .. .. .. | £53,634 | 4·41d. | **£68,942** | 2·89d. | — 1·52d. |
| Meter rents, &c... .. .. | 1,319 | ·11d. | **1,687** | ·07d. | — ·04d. |
| Sale and repairs of lamps and fittings, &c.* | 2,864 | ·24d. | **2,069** | ·09d. | — ·15d |
| Rents received, &c. .. .. | 684 | ·06d. | **806** | ·03d. | — ·03d· |
| Gross revenue ... | £58,501 | 4·82d. | **£73,504** | 3·08d. | 1·74d. |

* Manufacturing account (sales and repairs, less wages and material).

The costs of such a large system are interesting. It will be noticed that of the total 1·4d., coal is accountable for ·4d., leaving 1d. for all the other items. Of this, wages and salaries each take about ¼d., leaving a little over ½d. to cover the remainder. Of these, the most important is repairs, taking ½d. The changes amount to a fall of nearly 1d., of which about half is due to the last item, which requires a word of explanation. In 1898 there appeared an extraordinary item of "Cost of change of pressure of supply, £5,895." This was obviously a special charge against revenue, and we have therefore not treated it as repairs.

COST OF PRODUCTION.

| | 1898. Gross. | 1898. Per unit. | 1899. Gross. | 1899. Per unit. | Increase. |
|---|---|---|---|---|---|
| Coal, and unloading same.. | £5,865 | ·48d. | £10,116 | **·42d.** | — ·06d. |
| Oil, waste, water and engine room stores. | 1,262 | ·11d. | 1,636 | **·07d.** | — ·04d. |
| Salaries and wages incurred in generation and distribution. | 4,378 | ·36d. | 5,913 | **·25d.** | — ·11d. |
| Repairs and maintenance of buildings, engines, boilers, dynamos, &c. | 2,675 | ·22d. | 4,729 | **·20d.** | — ·02d. |
| Works costs ... | £14,180 | 1·17d. | £22,394 | **·94d.** | — ·23d. |
| Rent, rates and taxes .. | 2,494 | ·21d. | 3,577 | **·15d.** | — ·06d. |
| Management expenses, salaries of managing engineer, secretary, clerks, &c. | 4,764 | ·39d. | 4,947 | **·21d.** | — ·18d. |
| General establishment charges, stationery and printing, law charges and insurance | 1,374 | ·11d. | 2,204 | **·09d.** | — ·02d. |
| Other expenses, changing pressure of supply, certification of meters, &c. | 6,088 | ·50d. | 426 | **·02d.** | — ·48d. |
| Total costs ... | £28,900 | 2·38d. | £33,548 | **1·41d.** | — ·97d. |

The profit in 1899 was sufficient when taken with a balance of £1,555 from 1898 to allow £5,207 to be paid into the reserve fund and £6,000 to the renewal fund. The former now stands at £23,720 and the latter at £21,977.

PROFIT STATEMENT.

| | 1898. | 1899. |
|---|---|---|
| Interest on loans, &c. .. .. .. .. | £13,170 | £18,618 |
| Sinking fund for repayments .. .. .. | 8,890 | 11,722 |
| Net profit carried to renewal and reserve funds | 7,541 | 9,616 |
| Net profit carried forward .. .. .. | ... | ... |
| Gross profit ... ... | £23,601 | £39,956 |

**Aberdeen Corporation Electricity Accounts.**

The accounts of the Corporation of Aberdeen electric lighting department are among those which are not made up exactly in the Board of Trade form, nor do they include the same period as most others. Thus the two analysed below cover respectively periods of 7 months and 12 months, the latter being for the financial year, July 31st, 1899, to July 31st, 1900. In the majority of instances it is found that the period ending March 25th or 31st is most convenient; it is unusual to find the end of July chosen.

The accounts presented introduce two items which materially affect the results. After protracted negotiations, the Harbour Commissioners arranged with the Corporation to light the harbour, a much needed reform. Mr. J. Alex. Bell, the Corporation electrical engineer, has also now the advantage of a traction load. There was a time when the City Council hardly appreciated the good work done in the electrical department, with the result that Mr. Ruthven Murray and Mr. Blackman migrated to more congenial and appreciative southern undertakings.

GENERAL STATEMENT.

| | 1899. Seven months only. | 1899—1900. Twelve months. | Increase. |
|---|---|---|---|
| Total capital expenditure (less depreciation) ... ... ... | £69,713 | **£93,366** | £23,653 |
| Number of units sold ... ... | 256,653 | **846,012** | 589,359 |
| Gross revenue ... ... ... | £4,805 | **£14,553** | £9,748 |
| Gross expenditure... ... ... | £2,081 | **£5,946** | £3,865 |
| Gross profit ... ... ... | £2,724 | **£8,607** | £5,883 |
| Average price per unit sold ... | 4·49d. | **3·91d.** | — ·58d. |

It is rather difficult to institute any comparison between, or comment upon accounts, covering such different periods. The only explanation required, is perhaps that under "repairs" in the costs, is included an item of £169 for outlay on men's time and material in carboning and attending to the harbour lamps, and this ought to be treated as an extraordinary expenditure, but as the accounts are made up it is regarded as a maintenance charge. The electrical department supplies the tramway department with current at cost price, including interest and sinking fund.

REVENUE STATEMENT.

| | 1899. Gross. | 1899. Per unit. | 1899—1900. Gross. | 1899—1900. Per unit. | Increase. |
|---|---|---|---|---|---|
| Sale of energy .. .. .. | £4,805 | 4·49d. | **£13,787** | 3·91d. | — ·58d. |
| Meter rents, &c. .. .. | ... | ... | ... | ... | ... |
| Hire of motors and attendance harbour lamps. | ... | ... | **309** | ·09d. | + ·09d. |
| Services of engineer, &c., on tramways. | ... | ... | **457** | ·13d. | + ·13d. |
| Gross revenue ... | £4,805 | 4·49d. | **£14,553** | 4·13d. | — ·36d. |

The present capacity of plant installed is 1,156 KW., while the maximum load reached was 765 KW. The total connections for the year 1899-1900 was 30,068 lamps, made up of arcs, 1,830; incandescents, 9,529; and motors, 18,709; 33 watts lamps or equivalent. There are now 63 motors on the mains, representing 192 H.P., and the grand total of equivalent 8-C.P. connections of all classes was 71,995. The connections given are exclusively of the tramway supply.

COST OF PRODUCTION.

| | 1899. Gross. | 1899. Per unit. | 1899—1900. Gross. | 1899—1900. Per unit | Increase. |
|---|---|---|---|---|---|
| Coal .. .. .. .. .. | £563 | ·53d. | £2,428 | **·69d.** | + ·16d. |
| Oil, waste, water and engine room stores. | 91 | ·08d. | 296 | **·08d.** | ·00d. |
| Salaries and wages incurred in generation and in distribution. | 512 | ·48d. | 932 | **·27d.** | — ·21d. |
| Repairs and maintenance of buildings, engines, boilers, dynamos, &c., and harbour lamps. | 408 | ·38d. | 778 | **·22d.** | — ·16d. |
| Works costs ... ... | £1,574 | 1·47d. | £4,434 | **1·26d.** | — ·21d. |
| Rent, rates and taxes .. | 82 | ·08d. | 740 | **·21d.** | + ·13d. |
| Management expenses, salaries of managing engineer, secretary, clerks, &c. | 192 | ·18d. | 360 | **·10d.** | — ·08d. |
| Establishment charges, stationery and printing, law charges and insurance | 203 | ·19d. | 373 | **·11d.** | — ·08d. |
| Other expenses, compensation, &c. | 30 | ·03d. | 39 | **·01d.** | — ·02d. |
| Total costs ... | £2,081 | 1·95d. | £5,946 | **1·69d.** | — ·26d. |

The profit statement shows how carefully the depreciation account is kept. Each item on the capital is systematically and regularly depreciated, and any further surplus is put to reserve.

Profit Statement.

| | 1899. | 1899—1900. |
|---|---|---|
| Interest on loans .. .. .. .. .. .. | £1,049 | £2,344 |
| Sinking fund for repayments .. .. .. .. | 771 | 1,336 |
| Net profit carried to depreciation account .. .. | 904 | 2,439 |
| " " reserve fund .. .. .. | ... | 2,284 |
| " " forward .. .. .. .. | ... | 204 |
| Gross profit ... ... ... | £2,724 | £8,607 |

## CITY NOTES.

### Kidderminster and District Electric Lighting and Traction Company.

An extraordinary general meeting of the Kidderminster and District Electric Lighting and Traction Company will be held on September 21st, for the purpose of considering the following resolution:—

That the proposed Kidderminster and Bewdley Light Railway Order, a draft of which has been submitted to the meeting, be and is hereby approved, subject to all such alterations, additions, and variations as the Light Railway Commissioners or the Board of Trade may think fit to make or sanction therein.

### The Direct Spanish Telegraph Company, Limited.

—The board have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., free of income-tax, on the ordinary shares, both for the half-year ended June 30th, 1900, and payable on October 1st next.

## TRAFFIC RECEIPTS.

**The Blackpool and Fleetwood Tramroad Company.**—The receipts for the week ending September 16th, 1900, were £1,339 11s. 5d.; receipts for corresponding period, 1899, £1,136 6s. 8d.; aggregate for half-year to date, £15,850 1s. 3d.; aggregate corresponding period of last half-year, £15,987 9s. 3d.

**The Bristol Tramways and Carriage Company.**—The receipts for the week ending September 14th, 1900, were £3,683 3s. 9d.; corresponding period, 1899, £3,350 10s. 6d.; increase, £332 13s. 3d.

**The City and South London Railway Company.**—The receipts for the week ending September 16th, 1900, £1,506; September 17th, 1899, £868; increase, £638. Total receipts for half-year, 1900, to date, £16,528; corresponding period, 1899, £10,307; increase, £6,221. Miles open, 1900, 4½; 1899, 3½.

**The Cork Electric Tramways and Lighting Company.**—The receipts for the week ending Thursday, September 13th, 1900, were £502 19s. 3d.; corresponding week last year, £494 18s. 6d.; increase, £8 0s. 9d. Total to September 13th, 1900, £15,245 17s. 10d.; corresponding period last year, £14,015 4s. 11d.; increase, £1,230 12s. 11d.

**The Central London Railway.**—The receipts for the week ending September 15th, 1900, were £4,833; previous week, £4,647; increase, £186. Total receipts to September 15th, 1900 (7 weeks), £32,308. Miles open, 6.

**The Dover Corporation Tramways.**—The receipts for the week ending September 15th, 1900, were £275 15s. 3d.; September 10th, 1899, £309 3s. 9d.; decrease, £33 8s. 6d. Total receipts to date, 1900, £7,692 4s. 6d.; corresponding period, 1899, £7,383 0s. 9d.; increase, £308 3s. 9d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 5,198; 1899, 5,444. Number of cars, 1900, 11; 1899, 11.

**The Dublin United Tramways Company.**—The receipts for the week ending Friday, September 14th, 1900, were as follows:—D. U. T. Co., horse cars, £29 1s. 10d.; ditto, electric cars, £3,840 6s. 1d.; D. S. D. Co., electric cars, £1,079 0s. 1d.; total, £4,948 8s. 0d; corresponding week last year—D. U. T. Co., horse cars, £1,160 10s. 7d.; ditto, electric cars, £2,011 0s. 7d.; D. S. D. Co., electric cars, £891 18s. 10d.; total, £4,063 10s. 0d.; increase, £884 18s. 0d.; aggregate to date, £55,934 3s. 4d.; aggregate to date last year, £50,899 12s. 4d.; increase to date, £5,084 11s. 0d. The mileage worked is 43 miles electrically, 1 mile by horses, as against 24 miles electrically, 20 miles by horses, for the corresponding period last year.

**The Halifax Corporation Tramways.**—The receipts for the week ending September 16th, 1900, were £949; corresponding period, 1899, £684; increase, £265. Total receipts to date, 1900, £19,416; corresponding period, 1899, £15,216; increase, £4,200. Miles of track open, 1900, 16½; 1899, 9. Number of cars, 1900, 29; 1899, 21.

**The Liverpool Overhead Railway Company.**—The receipts for the week ending September 16th, 1900, were £1,719; corresponding week last year, £1,484; increase, £235. Total traffics from July 1st, 1900, £19,206; ditto corresponding period, 1899, £18,753; increase, £453. Miles open, 6·57 chains.

## STOCKS AND SHARES.

Wednesday Evening.

Cheerfulness is again the principal characteristic of the markets connected with electrical stocks and shares. The supply department, in particular, is enjoying a spell of what might almost be termed good business, although in the more general markets of the Stock Exchange the universal plaint is one of lack of trade. Telegraph descriptions maintain their quotations, and a rising tendency is the chief point of note in this section. The Electric Railway and Traction markets are extremely quiet; manufacturing shares are more easily sold than bought.

Supply shares claim attention first as being one of the best markets in the "House." The rise was started by City of London shares, in which a deal of good buying is going on, those closely connected with the company being said by the market to be the principal purchasers. We hear that the company has just completed some important new works, which will, it is anticipated, turn out to the shareholders' extreme satisfaction. Whatever the cause, the price of the Ordinary shares has risen 20s. on the week, after being 10s. better, while the Preference are 10s. to the good—a quite extraordinary move in City of Londons nowadays.

St. James's Ordinary are ½ up, and these, together with Westminsters, we have frequently mentioned as likely to advance in capital value. London Electrics have continued their rise, for the reasons that we detailed last week. The Ordinary shares are now at a sovereign discount. Among Debenture stocks it has been the turn of Chelseas to put on the usual 1 per cent. this week. We are not so sure that the best speculative purchase in this department is not London Electric 4 per cent. First Mortgage Debenture Stock, which stands at par. County of London 4½ per cents. would go better were there any free market in the stock, but it is too tightly held to be actively dealt in, and, moreover, the new stock is about 2 per cent. cheaper, while in a fortnight's time the two issues will be ranking *pari passu* in every respect.

Metropolitan shares are down a pound, simply because holders are selling their old and buying the new with the proceeds, thereby securing a small "turn." Business in the new shares is brisk, and the price, after dipping to 1¾ prem., has recovered to 2¼, the same as it was this time last week. With reference to the question as to when the old and new Metropolitans will be on all fours, about which we wrote last week, we are now able to state definitely that they will not be all alike until January, 1902.

The strength of the Electric Supply market will surprise no one who has followed these notes. We have shown how jobbers in the market have had shares literally forced upon them, which they have only taken at ridiculously low prices—and that reluctantly. Now that the turn has come, these dealers are by no means eager to sell the shares they have kept on their books for months past, and the people outside who have also held are equally disinclined to sell at a time when it appears probable that the market may go considerably better. A good demand for shares, and a limited supply, is causing the whole section to advance perceptibly.

Telegraph stocks, as already mentioned, are well supported, while attracting but little attention. Anglo-Americans have grounded for the time being, and the Ordinary has even gained a point. Beyond this no alteration has occurred in any of the Ordinary stocks and shares in this department. West India and Panama 5 per cent. Debentures are again 1 up, and the second Preference shares are receiving some support, with a resultant rise of 10s. The Ordinary do not move, although, as a speculation, they are possibly cheap at 17s. 6d. for the £10 shares fully paid up. They were sold on Tuesday as low as 15s. in the market. A sharp fall took place in Reuter's shares, a seller attempting to force a few on an unwilling market. The price has consequently receded 10s. a share.

The Electrical Railway group remains about the same, the only noticeable fluctuation being a recovery of the 1 per cent. which Waterloo and City stock lost last week. Central Londons are 10½, and Great Northern and City "A" are £6. Some talk is going the rounds to the effect that the prospectus will very shortly be advertised of the Baker Street and Waterloo Railway, but nothing definite can be ascertained at present on this subject. As regards the statement that an American syndicate is about to construct a "tube" line between Charing Cross and Hampstead *viâ* Euston, the Stock Exchange treats the whole story as a joke. The "Drain" stocks are irregular, Districts being weak at 26¾, and Metropolitan harder at 95. Neither company seems to be pressing its proposals of electrical traction at present, so far as can be judged by the unfortunate travellers on those systems.

India-Rubber and Gutta-Percha shares are dull at 21, the price of copper militating, according to market gossip, against the company's prosperity. Henley's are again decidedly harder, and have now fully recovered from the effects at first produced by the new issue. The manufacturing brigade, as a whole, is quiet, but so far it has not suffered from the weakening effect which a General Election traditionally brings to industrial departments, owing to shares coming on the market in order to find the wherewithal necessary for electioneering expenses.

## SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

| Present Issue. | NAME. | Stock or Share. † | Dividends for the last three years. 1897. | 1898. | 1899. | Closing Quotation September 12th. | Closing Quotation September 19th. | Business done during week ended September 19th, 1900. Highest. | Lowest. |
|---|---|---|---|---|---|---|---|---|---|
| 110,900 | African Direct Telegraph, 4 % Debs. ... ... ... | 100 | ... | ... | ... | 99 —103 | 99 —103 | ... | ... |
| 125,000 | Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ... | 100 | ... | ... | ... | 85 — 90 | 85 — 90 | ... | ... |
| 575,520 | Anglo-American Telegraph ... ... ... ... ... | Stock | 3 % | £3 9s. | 73/6 | 58 — 61 | 59 — 62 | 60 | ... |
| 3,062,240 | Do. do. 6 % Pref. ... ... ... | Stock | 6 % | 6 % | 6 % | 110½ 111½ | 110½—111½ | 111½ | 110½ |
| 3,062,240 | Do. do. Deferred ... ... ... | Stock | ... | 18s. % | £1 7s. | 11½— 12½ | 11½— 12½ | 12½ | 12 |
| 44,000 | Chili Telephone, Nos. 1 to 44,000 ... ... ... ... | 5 | 4 % | 3 % | 4 % | 2½— 3½ | 2½— 3½ | ... | ... |
| 10,000,000$ | Commercial Cable ... ... ... ... ... ... | $100 | 8 % | 8 % | ... | 165 —175 | 165 —175 | ... | ... |
| 1,063,078£ | Do. do. Sterling 500 year 4 % Deb. Stock Red. | Stock | ... | ... | ... | 101 —103 | 101 —103 | 102⅜ | 102½ |
| 16,000 | Cuba Telegraph ... ... ... ... ... ... | 10 | 7 % | 8 % | 7 % | 6½— 7½ | 6½— 7½ | 6⅞ | ... |
| 6,000 | Do. 10 % Pref. ... ... ... ... ... | 10 | 10 % | 10 % | ... | 15 — 16 | 15 — 16 | ... | ... |
| 12,931 | Direct Spanish Telegraph ... ... ... ... ... | 5 | 4 % | 4 % | ... | 4 — 5 | 4 — 5 | ... | ... |
| 6,000 | Do. do. 10 % Cum. Pref. ... ... ... | 5 | 10 % | ... | ... | 9 — 10 | 9 — 10 | ... | ... |
| 30,000 | Do. do. 4½ % Debs. ... ... ... | 50 | ... | ... | ... | 100 —104 % | 100 —104% | ... | ... |
| 60,710£ | Direct United States Cable ... ... ... ... ... | 20 | 3½% | 3½% | 3 % | 10⅜— 11¼ | 10⅜— 11¼ | 11⅛ | 10 13/16 |
| 111,000 | Direct West India Cable, 4½ % Reg. Deb. ... ... ... | 100 | ... | ... | ... | 99 —102 | 99 —102 | ... | ... |
| 4,000,000 | Eastern Telegraph, Ord. Stock ... ... ... ... | Stock | 7 % | 7 % | 7 % | 149 —154 | 149 —154 | 151½ | 149 |
| 1,195,000 | Do. 3½ % Pref. Stock ... ... ... | 100 | ... | ... | ... | 99 —102 | 99 —102 | 100 | 99 |
| 1,332,268£ | Do. 4 % Mort. Deb. Stock Red. ... ... | Stock | 4 % | ... | ... | 114 —119 | 114 —119 | 117 | 115 |
| 250,000 | Eastern Extension, Australasia, and China Telegraph ... | 10 | 7 % | 7 % | 7 % | 15 — 15¼ | 15 — 15½ | 15⅜ | 15⅛ |
| 6,700£ | Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326 | 100 | 5 % | ... | ... | ... — ... | ... — ... | ... | ... |
| 26,600£ | Do. do. Bearer, 1,050—3,975, 4,327—6,400 | 100 | 5 % | ... | ... | ... — ... | ... — ... | ... | ... |
| 320,000£ | Do. 4 % Deb. Stock ... ... ... ... ... | Stock | 4 % | ... | ... | 113 —118 | 113 —118 | ... | ... |
| 300,000£ | Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909 | 100 | ... | ... | ... | 99 —102 | 99 —102 | 101⅜ | 100 |
| 200,000£ | Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000 | 25 | ... | ... | ... | 100 —103% | 100 —103% | ... | ... |
| 180,227 | Globe Telegraph and Trust ... ... ... ... ... | 10 | 4½% | 5⅛% | 5⅛% | 11 —11½ | 11 — 11½ | 11 3/16 | 11 |
| 180,042 | Do. do. 6 % Pref. ... ... ... | 10 | 6 % | 6 % | ... | 14⅜— 15¼ | 14⅜— 15¼ | 15 3/16 | 14 13/16 |
| 150,000 | Great Northern Telegraph, of Copenhagen ... ... | 10 | 10 % | 12½% | ... | 32 — 34 | 32 — 34 | ... | ... |
| 84,300 | Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red. | 100 | ... | ... | ... | 98 —101 | 98 —101 | ... | ... |
| 17,000 | Indo-European Telegraph ... ... ... ... ... | 25 | 10 % | 10 % | 10 % | 51 — 55 | 50 — 54 | ... | ... |
| 100,000£ | London Platino-Brazilian Telegraph, 6 % Debs. ... ... | 100 | 6 % | ... | ... | 103 —106 | 103 —106 | ... | ... |
| 72,680 | Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ... | 1 | ... | ... | ... | ¼— ⅛ | ¼— ⅛ | ... | ... |
| 86,492 | Do. do. do. 5 % Pref., Nos. 1 to 86,492 | 1 | 4 % | 4 % | 2½% | ¾— 1 | ¾— 1 | ... | ... |
| 490,000 | National Telephone, 1 to 490,000 ... ... ... ... | 5 | 6 % | 6 % | 5 % | 4⅜— 4⅞ | 4⅜— 4⅞ | 4⅞ | 4⅜ |
| 15,000 | Do. 6 % Cum. 1st Pref. ... ... ... | 10 | 6 % | 6 % | 6 % | 13 — 15 | 13 — 15 | ... | ... |
| 15,000 | Do. 6 % Cum. 2nd Pref. ... ... ... | 10 | 6 % | 6 % | 6 % | 13 — 15 | 13 — 15 | ... | ... |
| 250,000 | Do. 5 % Non-cum. 3rd Pref., 1 to 250,000 | 5 | 5 % | 5 % | 6 % | 5 — 5¼ | 5 — 5¼ | 5⅛ | ... |
| 2,000,000£ | Do. 3½ % Deb. Stock Red. ... ... | Stock | 3½% | 3½% | 3½% | 98 —101 | 98 —101 | ... | ... |
| 171,504 | Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid | 1 | 5 % | 5 % | 5 % | ¾— 1⅛ | ¾— 1⅛ | ... | ... |
| 100,000£ | Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ... | 100 | 4 % | ... | ... | 100 —103 | 100 —103 | ... | ... |
| 11,839 | Reuter's ... ... ... ... ... ... ... ... | 8 | 5 % | 5 % | 5 % | 7½— 8½ | 7 — 8 | 7¼ | ... |
| 3,381 | Submarine Cables Trust ... ... ... ... ... | Cert. | ... | ... | ... | 125 —130 | 126 —131 | 127½ | 126½ |
| 58,000 | United River Plate Telephone ... ... ... ... | 5 | 5 % | 6 % | 7 % | 4⅜— 5¼ | 4⅜— 5¼ | ... | ... |
| 16,639 | Do. do. 5 % Cum. pref. Nos. 1—16,639 | 5 | ... | ... | ... | 4⅜— 5¼ | 4⅜— 5¼ | ... | ... |
| 179,947 | Do. do. 5 % Debs. ... ... ... | Stock | ... | ... | ... | 104 —107 | 104 —107 | ... | ... |
| 200,000£ | West African Telegraph, 5 % Debs.... ... ... ... | 100 | ... | ... | ... | 97 —100 | 98 —101 | ... | ... |
| 30,008 | West Coast of America, Nos. 1—30,000 and 53,001—53,008 | 2½ | ... | ... | ... | ½— 1 | ½— 1 | ... | ... |
| 150,000 | Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel. | 100 | ... | ... | ... | 99 —102 | 99 —102 | 100 | ... |
| 389,731 | Western and Brazilian Telegraph 4 % Deb. Stock Red. ... | Stock | ... | ... | ... | ... — ... | ... — ... | ... | ... |
| 207,930 | Western Telegraph, Ltd., Nos. 1—207,930 ... ... ... | 10 | 7 % | 7 % | ... | 14⅜—15¼ | 14⅜— 15¼ | 15⅛ | 14⅞ |
| 75,000 | Do. do. 5 % Debs. 2nd series, 1906 ... | 100 | ... | ... | ... | 103 —106 | 103 —106 | ... | ... |
| 88,321 | West India and Panama Telegraph ... ... ... ... | 10 | ¾% | 2 % | ¾% | ⅜— 1 | ⅜— 1 | 1 1/16 | ⅜ |
| 34,563 | Do. do. do. 6 % Cum. 1st Pref. ... | 10 | 6 % | ... | ... | 6½— 7½ | 6½— 7½ | ... | ... |
| 4,669 | Do. do. do. 6 % Cum. 2nd Pref. ... | 10 | 6 % | ... | ... | 5½— 6½ | 6 — 7 | ... | ... |
| 80,000£ | Do. do. do. 5 % Debs., Nos. 1 to 1,800 | 100 | 5 % | ... | ... | 104 —107 | 105 —108 | ... | ... |

## ELECTRICITY SUPPLY COMPANIES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 19,661 | Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761 | 5 | 4 % | 6 % | 6 % | 7 — 8 | 7 — 8 | ... | ... |
| 12,000 | Do. do. 7 % Cum. Pref.... | 5 | 7 % | ... | ... | 8½— 9½ | 8½— 9½ | ... | ... |
| 50,000 | Charing Cross and Strand Electricity Supply ... ... | 5 | 7 % | 8 % | 9 % | 9 — 10 | 9 — 10 | 9⅜ | ... |
| 20,000 | Do. do. do. do. 4½% Cum. Pref. | 5 | ... | ... | ... | 5½— 5⅝ | 5½— 5⅝ | 5⅝ | 5⅛ |
| 34,000 | *Chelsea Electricity Supply, Ord. ... ... ... ... | 5 | 6 % | 6 % | 6 % | 6½— 7½ | 6½— 7½ | 7⅛ | 7 |
| 150,000 | Do. do. do. % Deb. Stock Red. ... | Stock | 4½% | ... | ... | 108 —111 | 109 —112 | ... | ... |
| 60,000 | City of London Electric Lighting, Ord. 40,001—100,000... | 10 | 10 % | 6 % | 4 % | 8 — 9 | 9 — 10 | 10 | 9⅜ |
| 40,000 | Do. 6 % Cum. Pref., 1 to 40,000 ... ... ... | 10 | 6 % | 6 % | ... | 12 — 13 | 12½—13½ | ... | ... |
| 400,000 | Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid | ... | 5 % | ... | ... | 124 —129 | 124 —129 | ... | ... |
| 40,000 | County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000 | 10 | *nil* | *nil* | 4 % | 8½— 9½ | 8½— 9½ | 9 | ... |
| 20,000 | Do. do. do. 6 % Pref., 40,001—60,000 | 10 | 6 % | 6 % | ... | 11 — 12 | 11 — 12 | ... | ... |
| 200,000 | Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ... | ... | ... | ... | ... | 107 —110 | 107 —110 | ... | ... |
| 26,100 | Edmundson's Elec. Corp., Ord. Shares ... ... ... | 5 | 5 % | 7 % | ... | 4½— 5 | 4½— 5 | ... | ... |
| 75,000 | Do. do. 4½ % 1st Mort. Deb. Stock. ... | 100 | ... | ... | ... | 99 —102 | 99 —102 | ... | ... |
| 110,000 | London Electric Supply Corporation, Limited, Ord. ... | 3 | ... | ... | ... | 1½— 1⅝ | 1⅝— 2½ | 2 | 1⅝ |
| 49,840 | Do. do. do. do. 6 % Pref. | 5 | ... | 6 % | ... | 4 — 5 | 4½— 5½ | 4⅝ | ... |
| 250,000 | Do. do. do. 4% 1st Mt. Db. Stock Rd. | Stock | ... | ... | ... | 99 —101 | 100 —102 | ... | ... |
| 85,000 | Metropolitan Electric Supply, 101 to 62,500 ... ... | 10 | 6 % | 5 % | 5 % | 14 — 15 | 13 — 14 | 14 | ... |
| 220,000£ | Do. 4½% First Mortgage Debenture Stock | ... | 4½% | ... | ... | 111 —114 | 111 —114 | 111½ | ... |
| 220,000 | Do. 3½% Mort. Deb. Stock Red. ... ... | Stock | ... | ... | ... | 96 — 98 | 96 — 98 | 97½ | 97 |
| 6,452 | Notting Hill Electric Lighting ... ... ... | 10 | 6 % | 6 % | 7 % | 14½— 15½ | 14½— 15½ | ... | ... |
| 40,000 | St. James's and Pall Mall Electric Light, Ord. ... ... | 5 | 14½% | 14½% | 14½% | 14 — 15 | 14½— 15½ | 15 | ... |
| 20,000 | Do. do. 7 % Pref., 20,081 to 40,080 | 5 | 7 % | 7 % | 7 % | 8 — 9 | 8 — 9 | 8⅝ | ... |
| 12,000 | Smithfield Market Elect. Supply, Ord. ... ... ... | 5 | ... | ... | ... | 2 — 2½ | 2 — 2½ | ... | ... |
| 50,000 | Do. do. 4 % Deb. ... ... ... | 100 | ... | ... | ... | 85 — 95 | 85 — 95 | ... | ... |
| 65,000 | South London Electricity Supply, Ord. ... ... ... | 5 | ... | ... | ... | 3 — 4 | 3 — 4 | ... | ... |
| 79,900 | Westminster Electric Supply, Ord., 101 to 80,000... ... | 5 | 12 % | 12 % | 13 % | 12 — 13 | 12 — 13 | 12⅜ | 12 1/16 |

* Subject to Founders Shares.
† Unless otherwise stated all shares are fully paid.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.

## SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

### ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

| Present Issue. | NAME. | Stock or Share. | Dividends for the last three years. 1897. | 1898. | 1899. | Closing Quotation Sept. 12th. | Closing Quotation Sept. 19th. | Business done week ended Sept. 19th, 1900. Highest | Lowest. |
|---|---|---|---|---|---|---|---|---|---|
| | | ‡ | | | | | | | |
| 65,000 | Aluminium shares, Nos. 1—65,000 ... ... ... ... | 1 | 10 % | 20 % | ... | 2⅜— 3 | 2⅜— 3 | ... | ... |
| 90,000 | Do. 4½ % 1st Mort. Deb. Stock Red. ... ... | Stock | ... | ... | ... | 96 —101 | 96 —101 | ... | ... |
| 30,000 | British Electric Traction ... ... ... ... ... | 10 | ... | 6 % | ... | 14½— 15½ | 14½— 15½ | 15½ | 15 |
| 50,000 | Do. do. 6 % Cum. Pref. ... ... ... | 10 | ... | ... | ... | 12 — 13 | 12 — 13 | 12⅞ | 12¾ |
| 200,000 | Do. do. 5 % Perpetual Debenture Stock ... | Stock | ... | ... | ... | 123 —126 | 123 —126 | ... | ... |
| 85,000*l* | †British Electric Works Co., Ord. £1 shares, 50,001—135,000 | ... | ... | ... | ... | ⅜— ½ | ⅜— ½ | ... | ... |
| 50,000 | † Do do. 6 % Cum.Pref., 1—50,000 ... | ... | ... | ... | ... | ⅝— ⅞ | ⅝— ⅞ | ... | ... |
| 500 | † Do. do. 4½ % 1st Mort. Deb. ... ... | 100 | ... | ... | ... | 97 — 99 | 97 — 99 | ... | ... |
| 40,000 | British Insulated Wire Ord., Nos. 1 to 40,000 ... ... | 5 | 15 % | 15 % | 20 % | 11 — 12 | 11 — 12 | 11½ | 11¼ |
| 27,500 | Do. do. 6 % Cum. Pref. Nos. 1 to 27,000 ... | 5 | ... | ... | ... | 5⅝— 6¼ | 5⅝— 6¼ | ... | ... |
| 90,000 | Brush Elecl. Enging., Ord., 1 to 90,000 ... ... ... | 3 | 3 % | 5 % | ... | 1⅝— 1⅞ | 1¾— 2 | 1⅞ | 1¾ |
| 90,000 | Do. do. Non-cum. 6 % Pref., 1 to 90,000 ... | 2 | 6 % | 6 % | ... | 2¼— 2⅜ | 2¼— 2⅜ | 2⅜ | ... |
| 125,000*l* | Do. do. 4½ % Perp. Deb. Stock ... ... | Stock | ... | ... | ... | 106 —111 | 106 —111 | ... | ... |
| 50,000 | Do. do. 4½ % 2nd Deb. Stock Red ... ... | Stock | ... | ... | ... | 101 —103 | 101 —103 | ... | ... |
| 20,000 | Callender's Cable Construction shares, Nos. 1—20,000 ... | 5 | 12½% | 15 % | 15 % | 12½— 13½ | 12½— 13½ | ... | ... |
| 20,000 | Do. do. 5 % Cum. Pref. ... ... ... | 5 | ... | ... | ... | 5 — 5½ | 5 — 5½ | 5 7/16 | 5⅛ |
| 90,000 | Do. do. 4½ % 1st Mort. Deb. Stock Red ... | S ock | ... | ... | ... | 110 —114 | 110 —114 | ... | ... |
| 213,533 | Central London Railway, Ord. Shares ... ... ... | 10 | ... | ... | ... | 10 — 10½ | 10 — 10½ | 10⅜ | 10⅛ |
| 61,033 | Do. do. Pref. half-shares ... ... ... | 5 | ... | ... | ... | 5 — 5½ | 4¾— 5¼ | 5 5/16 | 5 |
| 71,447 | Do. do. Def. do. ... ... ... | 5 | ... | ... | ... | 5 — 5½ | 4¾— 5¼ | 5 3/16 | 5⅛ |
| 855,000 | City and South London Railway ... ... ... ... | Stock | 1⅞% | 2⅛% | 1⅞% | 57 — 60 | 58 — 61 | ... | ... |
| 37,500 | Do. do. Ord. shares Nos. 22,501 to 60,000 ... ... | 10 | ... | ... | ... | 5 — 6 | 5 — 6 | ... | ... |
| 32,098 | Crompton & Co., Nos. 1 to 32,098 ... ... ... ... | 3 | ... | 6 % | 7½% | 3¾— 4¼ | 3¾— 4¼ | ... | ... |
| 100,000 | Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red | ... | ... | ... | ... | 99 —102 | 99 —102 | ... | ... |
| 99,261 | Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261 | 5 | 6 % | 6 % | 6 % | 1⅞— 2¼ | 1⅞— 2¼ | ... | ... |
| 17,139 | Do. do. do. "A" Shares, 01—017,139 ... | 5 | 6 % | 6 % | 6 % | 3½— 4½ | 3½— 4½ | 4⅜ | ... |
| 344,023 | Do. do. do. 4 % Deb. Stock Red ... | 100 | ... | ... | ... | 90 — 92 | 90 — 92 | ... | ... |
| 112,100 | Electric Construction, 1 to 112,100 ... ... ... ... | 2 | 6 % | 6 % | 6 % | 1⅞— 2⅛ | 1⅞— 2⅛ | 2 1/16 | ... |
| 25,000 | Do. do. 7 % Cum. Pref., 1 to 25,000... ... | 2 | 7 % | 7 % | ... | 2⅞— 3¼ | 2⅞— 3¼ | ... | ... |
| 140,300 | Do. do. 4 % Perp. 1st Mort. Deb. Stock ... | Stock | ... | ... | ... | 102 —105 | 102 —105 | ... | ... |
| 9,600*l* | Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ... | 10 | 7 % | 7 % | 7 % | 10 — 11 | 10 — 11 | ... | ... |
| 30,000 | Henley's (W. T.) Telegraph Works, Ord. ... ... ... | 5 | 12 % | 14 % | 15 % | 12 — 13 | 12½— 13½ | 12 13/16 | 12¾ |
| 30,000 | Do. do. do. 4½ % Pref. ... ... | 5 | 7 % | 7 % | ... | 5 — 5½ | 5 — 5½ | 5 1/16 | ... |
| 50,000 | Do. do. do. 4½ Mort. Deb. Stock... | Stock | 4½% | ... | ... | 108 —112 | 108 —112 | ... | ... |
| 50,000 | India-Rubber, Gutta-Percha and Telegraph Works ... | 10 | 10 % | 10 % | ... | 21 — 22 | 20½— 21½ | 21 5/16 | 20¾ |
| 300,000 | Do. do. do. 4 % 1st Mort. Deb ... ... | 100 | ... | ... | ... | 101 —104 | 101 —104 | ... | ... |
| 37,500 | †Liverpool Overhead Railway, Ord. ... ... ... | 10 | 3½% | 3½% | 3¾% | 8⅞— 9 | 8¾— 9 | ... | ... |
| 10,000 | † Do. do. Pref., £10 paid ... ... | 10 | 5 % | 5 % | 5 % | 13 — 13¼ | 12¾— 13¼ | ... | ... |
| 37,350 | Telegraph Construction and Maintenance ... ... ... | 12 | 15 % | 15 % | 15 % | 35 — 39 | 35 — 39 | 36½ | 35 |
| 150,000 | Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ... | 100 | ... | ... | ... | 101 —104 | 101 — 104 | ... | ... |
| 20,000 | Telegraph Manufacturing, Ord. Nos. 1 to 20,000 ... ... | 5 | ... | 8 % | 12 % | 10½— 11½ | 10½— 11½ | ... | ... |
| 20,000 | Do. do. 5 % Cm. Prf. Nos. 1 to 20,000... | 5 | ... | ... | ... | 5⅛— 5⅜ | 5⅛— 5⅜ | ... | ... |
| 540,000 *l* | Waterloo and City Railway, Ord. Stock ... ... ... | 100 | ... | 3 % | 3 % | 91 — 94 | 92 — 95 | 93 | 92 |

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 102—105.
National Electric Free Wiring, 12/6 paid, ⅜—¼.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 17—18 xd.
Do. do. Pref. (£10 pd.), 10—10½ xd.
* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 % £5 (fully paid), 6⅜—7¼. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 17¾.

**Bank rate of discount 4 per cent. (July 19th, 1900).**

## MARKET QUOTATIONS, Wednesday, September 19th.

| CHEMICALS, &c. | | This week. | Last week. | Inc. or Dec. |
|---|---|---|---|---|
| *a* Acid, Hydrochloric .. .. | per cwt. | 5/- | 5/- | .. |
| *a* ,, Nitric .. .. .. | per cwt. | 22/- | 22/- | .. |
| *a* ,, Oxalic .. .. .. | per cwt. | 32/- | 32/- | .. |
| *a* ,, Sulphuric .. .. | per cwt. | 5/6 | 5/6 | .. |
| *a* Ammoniac, Sal .. .. .. | per cwt. | 39/- | 39/- | .. |
| *a* Ammonia, Muriate (crystal) .. | per ton | £33 | £33 | .. |
| *a* ,, ,, .. | per ton | £30 | £30 | .. |
| *a* Bleaching powder .. .. | per ton | £7 | £7 | .. |
| *a* Bisulphide of Carbon .. .. | per ton | £15 | £15 | .. |
| *a* Borax .. .. .. .. | per ton | £17 | £17 | .. |
| *a* Bensole (90 %) .. .. .. | per gal. | 7/- | 7/- | .. |
| *a* ,, (50/90%).. .. .. | per gal. | 5/6 | 5/6 | .. |
| *a* Copper Sulphate .. .. | per ton | £25 10 | £25 10 | .. |
| *a* Lead, Nitrate .. .. .. | per ton | £25 | £25 | .. |
| *a* ,, White Sugar .. .. | per ton | £31 | £31 | .. |
| *a* ,, Peroxide .. .. .. | per ton | £27 10 | £27 10 | .. |
| *a* Methylated Spirit .. .. | per gal. | 2/6 | 2/6 | .. |
| *a* Naphtha, Solvent (90% at 160° C). | per gal. | 5/6 | 5/6 | .. |
| *a* Potash, Bichromate, in casks.. | per lb. | 3¾d. | 3¾d. | .. |
| *a* ,, Caustic (75/80%) .. | per ton | £24 | £24 | .. |
| *a* ,, Bisulphate .. .. | per ton | £35 | £35 | .. |
| *a* Shellac .. .. .. .. | per cwt. | 65/- | 65/- | .. |
| *a* Sulphate of Magnesia .. .. | per ton | £4 10 | £4 10 | .. |
| *a* Sulphur, Sublimed Flowers .. | per ton | £6 | £6 | .. |
| *a* ,, Recovered .. .. | per ton | £5 10 | £5 10 | .. |
| *a* ,, Lump .. .. .. | per ton | £5 | £5 | .. |
| *a* Soda, Caustic (white 70 %) .. | per ton | £10 15 | £10 15 | .. |
| *a* ,, Crystals .. .. | per ton | £3 | £3 | .. |
| *a* ,, Bichromate, casks .. | per lb. | 2¾d. | 2¾d. | .. |
| **METALS, &c.** | | | | |
| *b* Aluminium Wire, in ton lots.. | per ton | £224 | £224 | .. |
| *b* ,, Sheet, in ton lots | per ton | £191 | £191 | .. |
| *p* Babbitt's metal ingots.. .. | per ton | £80 to £ 50 | £80 to £150 | .. |
| *c* Brass (rolled metal 2" to 12") basis | per lb. | 7¾d. | 7¾d. | .. |
| *c* ,, Tube (brazed) .. .. | per lb. | 10d. | 10d. | .. |
| *c* ,, ,, (solid drawn) .. | per lb. | 8¼d. | 8¼d. | .. |
| *c* ,, Wire, basis .. .. | per lb. | 8¼d. | 8¼d. | .. |
| *c* Copper Tubes (brazed) .. | per lb. | 11¼d. | 11¼d. | .. |
| *c* ,, ,, (solid drawn) .. | per lb. | 11d. | 11d. | .. |
| *g* Copper Bars (best selected) .. | per ton | £85 | £85 | .. |

| METALS, &c. *(continued.)* | | This week. | Last week. | Inc. or Dec. |
|---|---|---|---|---|
| *g* Copper Sheet .. .. .. | per ton | £85 | £85 | .. |
| *g* ,, Rod .. .. .. .. | per ton | £85 | £85 | .. |
| *e* ,, (Electrolytic) Bars .. | per ton | £83 10 | £83 10 | .. |
| *e* ,, ,, Sheets .. | per ton | £92 | £92 | .. |
| *e* ,, ,, Rod .. | per ton | £85 10 | £85 10 | .. |
| *e* ,, ,, H.C. Wire | per lb. | 9¾d. | 9¾d. | .. |
| *f* Ebonite Rod .. .. .. .. | per lb. | 3/- | 3/- | .. |
| *f* ,, Sheet .. .. .. .. | per lb. | 5/- | 5/- | .. |
| *n* German Silver Wire .. .. | per lb. | 1/6 | 1/6 | .. |
| *h* Gutta-percha fine .. .. .. | per lb. | 8/6 | 8/6 | .. |
| *h* India-rubber, Para fine .. .. | per lb. | 3/11½ to 4/2½ | 3/11½ to 4/2½ | .. |
| *i* Iron, Charcoal Sheets .. .. | per ton | £18 | £18 | .. |
| *i* ,, Pig (Cleveland warrants) .. | per ton | .. | 71/9 | .. |
| *i* ,, Forgings, according to size | per ton | From £11 | From £11 | .. |
| *i* ,, Scrap, heavy .. .. .. | per ton | 70/- to 72/6 | 70/- to 72/6 | .. |
| *i* ,, Wire, galvanised No. 8 .. | per ton | £12 15 | £12 15 | .. |
| *g* Lead, English Ingot .. .. | per ton | £17 15 to £18 | £17 15 to £18 | .. |
| *g* ,, ,, Sheet .. .. | per ton | £19 | £19 | .. |
| *m* Manganin Wire No. 28 .. .. | per lb. | 8/- | 8/- | .. |
| *g* Mercury .. .. .. .. | per bot. | £9 2 6 | £9 5 | 2s. 6d. dec. |
| *d* Mica (in original cases), small .. | per lb. | 3d. to 9d. | 3d. to 9d. | .. |
| *d* ,, ,, ,, medium | per lb. | 1/9 to 2/9 | 1/9 to 2/9 | .. |
| *d* ,, ,, ,, large .. | per lb. | 3/3 to 7/3 | 3/3 to 7/3 | .. |
| *p* Phosphor Bronze, plain castings | per lb. | 1/1 to 1/4 | 1/1 to 1/4 | .. |
| *p* ,, rolled bars & rods | per lb. | 1/1 to 1/4 | 1/1 to 1/4 | .. |
| *p* ,, ,, strip & sheet | per lb. | From 1/3 | From 1/3 | .. |
| *o* Platinum .. .. .. .. | per oz. | £3 13 6 | £3 13 6 | .. |
| *p* Silicon Bronze Wire .. .. | per lb. | 10½d. to 1/1 | 10½d. to 1/1 | .. |
| *i* Steel, Magnet, acc'd'ng to desc'p'n | per ton | From £15 | to £40 | .. |
| ,, ,, in bars .. .. | | £58 | £58 | .. |
| *g* Tin, block .. .. .. .. | per ton | £133 to £134 | £140 to £141 | £7 dec. |
| *g* ,, foil .. .. .. .. | per lb. | 2/- | 2/- | .. |
| *n* ,, wire, Nos. 1 to 16 .. .. | per lb. | 1/9 | 1/9 | .. |
| *p* White Anti-friction Metals — | | | | |
| "White Ant" brand .. .. | per ton | £40 to £70 | £40 to £70 | .. |
| *j* Yarns, Cotton, Single 10 lb. b'ndl's | per lb. | 9½d. | 9½d. | .. |
| *j* ,, Best Flax, 6 lea. .. .. | per lb. | 6d. | 6d. | .. |
| *j* ,, Hemp, 3 ply 10 lbs. .. | per lb. | 4½d. | 4½d. | .. |
| *j* ,, ,, Russian, 10 lbs. .. | per lb. | 5⅝d. | 5⅝d. | .. |
| *j* ,, Jute, 180 lbs. rove .. | per ton | £14 10 | £14 10 | .. |
| *k* Zinc, Sh't. (Vielle Montagne ord.) | per ton | £24 5 nett. | £24 5 nett | .. |

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yeo & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.



## BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRADFORD, 1900.

The following is a list of the electrical papers read at Bradford :—

Prof. G. F. FitzGerald, F.R.S.—Note on M. Cremieu's Experiment.
Prof. G. F. FitzGerald, F.R.S.—Report of Committee on Radiation in a Magnetic Field.
Prof. W. B. Morton.—Note on the Propagation of Electric Waves along Parallel Wires.
Dr. S. H. Burbury, F.R.S.—On the Vector Potential of Electric Current in a Field where Disturbances are propagated with Finite Velocity.
Prof. D. P. Todd.—On the Application of the Electric Telegraph to the Furtherance of Eclipse Research.
C. S. Bradley.—On some new Chemical Compounds discovered by the use of the Electric Furnace.
Report of the Committee on the Electrolytic Methods of Quantitative Analysis.
Dr. McDonald.—Electrical changes in Mammalian Nerve. (Report.)
Report of the Committee on the most suitable Method of Determining the Magnetic Force on board ship. (This report was purely formal. An instrument had been embodied, and it seemed to have answered the purposes very well. It was to be tested more severely, and a more complete report will be presented next year.)
Report of the Committee on the Sizes of pages of Scientific Periodicals. (Purely formal.)
Prof. J. C. Bose.—On the Similarity of the effect of Electrical Stimulus on Inorganic and on Living Substances.
Sir William Preece, F.R.S.—Wireless Telephony.
C. E. S. Phillips.—On the Apparent Emission of Cathode Rays from an Electrode at Zero Potential.
Dr. G. Gore, F.R.S.—On Volta-Electromotive Force of Alloys.
Prof. F. G. Baily.—On a Lecture Room Volt-and Ammeter.
J. B. B. Burke.—On the Phosphorescent Glow in Gases.
J. McTaggart, A.M.Inst.M.E.—The Disposal of House Refuse in Bradford.
Prof. Hele Shaw, F.R.S.—Resistance of Road Vehicles to Traction.
J. Brown.—The Viagraph.
W. T. E. Binnie.—An Account of a New Form of Self-Registering Rain Gauge.
J. B. C. Kershaw.—Power Generation—Comparative Cost by the Steam Engine, Water Turbine, and Gas Engine.
J. G. W. Aldridge.—The Automobile for Electric Street Traction.
Sir W. H. Preece, F.R.S.—The Manchester and Liverpool Express Railway.
F. J. Behr.—The Manchester and Liverpool Express Railway—Signals and Brakes.
Prof. S. P. Thompson, F.R.S.—The Construction of Large Dynamos, as Exemplified at the Paris Exhibition.
W. Dawson.—Recent Tramway Construction, with Special Reference to the Demerbe Rail System.
A. Mallock.—Measurement of the Tractive Force, Resistance, and Acceleration of Trains.
T. Barker and Prof. Ewing, F.R.S.—On a Combination Integrating Wattmeter and Maximum Demand Indicator.
A. H. Gibbings.—The Design and Location of Electric Generating Stations.
W. A. Price.—Report of the Small Screw Gauge Committee.
C. P. Clements.—On Screw Threads used in Cycle Construction and for Screws subject to Vibration.
Prof. J. Goodman.—A New Form of Clariometer for Measuring the Wetness of Steam.
Electrical Standards Committee Report (Mr. Glazebrook).
E. H. Griffiths.—New Form of Wheatstone Bridge.
Mr. Whipple.—Improved Standard Resistance Coil.
Arthur Priestman.—Municipal Trading.
Evening Lecture:—Prof. Gotch, F.R.S., on "Animal Electricity."
" " (To Artizans) :—Prof. S. P. Thompson, F.R.S., "Electricity in Industries."

## THE AUTOMOBILE FOR ELECTRIC STREET TRACTION.

By J. G. W. Aldridge.

(*Section G, September 10th.*)

The title of this paper does not entirely represent the contents, because the system to be described is a combination of the automobile and overhead system.

At the meeting of this Section at Toronto, the author in his paper gave some particulars of the development of electric traction in England, and the certainty that the overhead system would develop, and to-day there is no town of importance in the country that has not either adopted, or has under consideration, electric tramways operated by the overhead wires, and probably had it not been for the prejudice against overhead wires, this system would not have been so long delayed in its general adoption.

There are still many towns and districts where the system has not been installed, and the author hopes the system to be described in this paper will overcome the objections, which are twofold, viz. :—

1. The overhead wires principally in large towns.
2. The cost of electric traction in small towns and extended districts with comparatively small populations.

1. In order to obviate the overhead wires which appear to be chiefly an æsthetic objection, either the conduit or the surface contact system is being adopted, but it is probable the authors of these systems will live to regret having spent so much money to attain results which other towns have obtained at so much less outlay both in first cost and maintenance.

2. The cost of electric traction is, from a commercial point of view, inadmissible in many towns and districts, owing to the certainty that the traffic would not repay even a reasonable percentage upon the outlay.

The choice of routes in laying down any system of tramways is largely decided upon by the density of the population in the locality under consideration, and, therefore, as this density lessens on the outskirts of our towns, it is at the moment a perplexing problem as to the best method from a commercial point :—

1. The extension of existing tramways.
2. The existing omnibus routes maintained; or,
3. Motor cars adopted to replace these omnibuses.

### 1. The Extension of Tramways.

The great difficulty in extending the lines is the cost of the permanent way.

It may be taken that a single line will not cost less than £4,500 complete, and the overhead equipment £1,500, making a total of £6,000, and it is probable this is a moderate estimate, because with the increased weight of cars for electric traction, as compared to horse cars, there is a tendency to lay down much heavier permanent way. Considering this from a ratepayer's point of view for a single track—

| | | | |
|---|---|---|---|
| The interest upon £4,500 at 3½ per cent. ... | £157 | 10 | 0 |
| Maintenance at ½d. per car mile, assuming a five minutes' service each way for 16 hours per day ... ... ... ... ... | 271 | 2 | 4 |
| Total ... ... | £428 | 12 | 4 |

excluding repayment of capital.

I have had some difficulty in arriving at a correct figure for maintenance, as this cost varies from £35 to £530 per mile of track. For instance, the maintenance per mile in several English towns, and also Boston, U.S.A., costs over £500 per annum, while in Hamburg it is as low as £130.

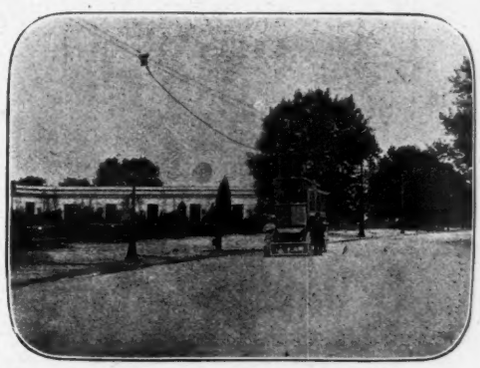


Fig. 1.

This is a small matter in a densely populated district, where the traffic is considerable; but in the towns and districts under consideration, it is sufficient to appreciably reduce the profit, or more probably turn this into a loss.

### 2. The Existing Omnibus Routes Maintained.

The experience of rapid and smooth transit in the electric tramcar has sealed the fate of the omnibus of the usual type, and already the 'bus companies recognise this, and great improvements are being made.

A well-known traveller has described the riding on a camel's back to being seated on a high office stool, placed on a wagon crossing a ploughed field, and the author thinks that a ride on the top of some of our 'buses is about as comfortable.

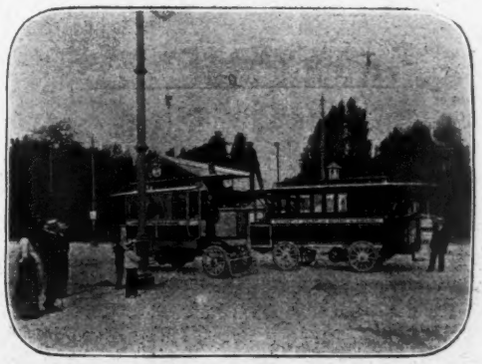


Fig. 2.

Under existing conditions there has been no other means of conveyance which is satisfactory from the commercial side for small traffic.

The cost of an omnibus of the best type is about £175, and this 'bus requires eight horses, averaging £35 each, making a total capital outlay of, say, £450 for each omnibus complete.

The working costs in a large provincial company, which include wages, food, and stabling, and all repairs, are no less than 8d. per 'bus-mile, excluding capital charges.

### 3. Automobiles to Replace Omnibuses.

This is a step in the right direction, but the great cost of the cars

and the working and upkeep are at the present time very unsatisfactory where a number of passengers have to be carried.

Several towns are experimenting with cars of various types, and in many cases have abandoned them.

If electricity is adopted the cars must be separately charged, and the weight of the accumulator is often equal to the car and its load.

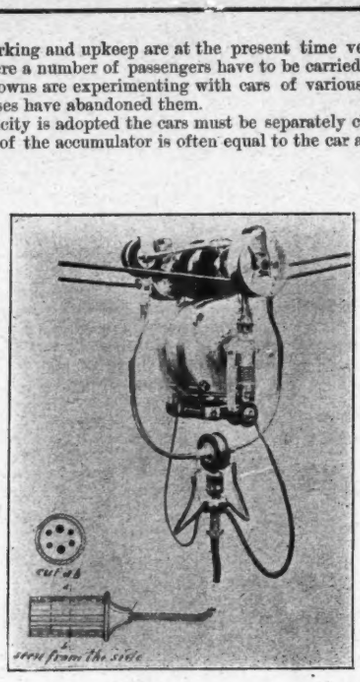


Fig. 3.

A new automobile has recently been described in the public papers, in which the weight of the battery and motor does not much exceed half the total weight of car and load.

Improvements in the relative weight of battery and car will undoubtedly take place, but so long as the car carries its own motive power there must of necessity be the additional weight which might otherwise be a paying load. Moreover, where accumulators are the motive power, and also oil and other engines, the maintenance is an item that cannot be ignored, and the efficiency losses in the accumulators are well known to be considerable.

The author is aware, from personal knowledge, of several towns which are undecided as to the best course to adopt, and is confident that the following system is a complete solution of the difficulty, the principal features of which are as follows:—

1. No permanent way is required.
2. Overhead equipment is reduced to a minimum.
3. The motor cars have only the weight of motor and gearing.
4. The system is worked from the same generating station and mains as the tramway system.
5. The first cost is therefore enormously reduced.
6. The cars or 'buses may run through any streets which allow vehicular traffic.

With the assistance of some views taken from actual photographs of the system, and cinematograph pictures thrown upon the screen, the author hopes to clearly demonstrate that this system is a solution of the present difficulty.

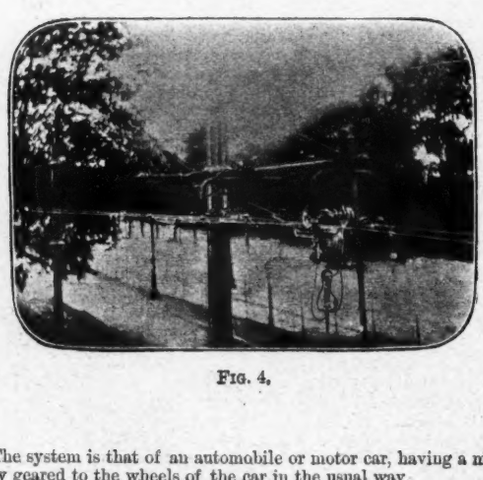


Fig. 4.

The system is that of an automobile or motor car, having a motor only geared to the wheels of the car in the usual way.

Instead of accumulators being carried by the automobile in the ordinary way, the power is taken from overhead wires, and the system adopted enables these overhead wires to be so fixed that they appear to be only telephone or telegraph wires by the roadside, and, therefore, entirely unobjectionable from an æsthetic point of view.

The idea of taking the power from overhead wires for motor carriages of various descriptions is not new.

When the motor car, as it practically is to-day, came before the public, some of the papers gave a prophetic series of pictures showing all sorts and conditions of cars, and even houses upon wheels, going in various directions and destinations, but it has remained for the inventor, Mons. Lombard Gerin, of Paris, to introduce and put to a practical test his idea upon a commercial basis.

1. The first photograph shows a road in the Forest of Vincennes, near Paris, with the overhead wires, and it will be seen that the road has the appearance of nothing more than a telephone or telegraph line by the side of the road.

Fig. 5.

The author showed several views from which we have made a selection. The overhead equipment is only a pole of comparatively slight scantling, with both positive and negative wires, supported on a very short bracket.

It is obvious that this arrangement is less than the ordinary overhead system, both in first cost and maintenance.

In place of the fixed trolley pole, which necessitates the car maintaining an approximate parallel position to the overhead wires, and, moreover, often requires the long bracket arms which are so

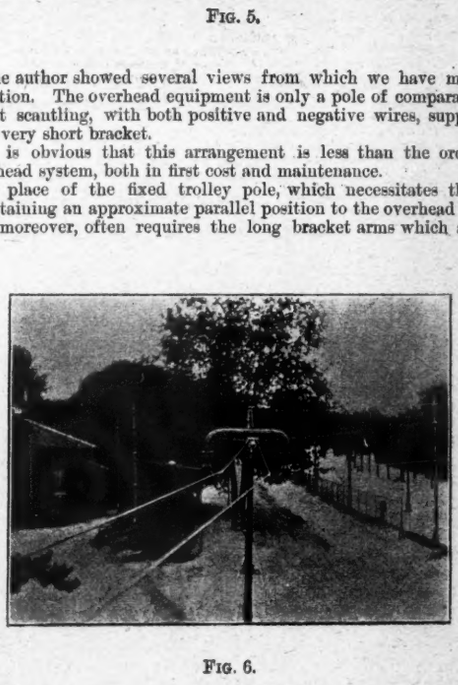


Fig. 6.

unsightly, in this system the connection is made by a flexible cable, which enables the motor car or 'bus to travel in any part of the road, and to turn complete circles without in any way entangling the connection with the overhead wires.

One of the views shows the trolley which travels along slightly in advance of the car.

This trolley is about 40 lbs. weight, made of aluminium, and runs upon the two wires driven by its own motor. One of the pictures shows the trolley enlarged, so as to make clear the arrangement, which is as follows:—

1. A three-phase motor on spring suspension, the revolving part or rotor of which is external.
2. Two trolley wheels, acting as rolling contacts on the positive and negative conductors.
3. Two fibre wheels, mounted on the spindles of the trolley wheels, which are frictionally driven by the above-mentioned rotor.
4. A framework carried on bearings on the trolley wheel spindles. To this is attached the flexible cable leading to the vehicle.

The action is as follows:—

Continuous current is conveyed *viâ* the trolley contact wheels, the

framework and the main conductors of the flexible cable to the controller and motor of the vehicle, which is propelled in the usual way. The motor armature, however, has at the end, remote from the commutator, three collecting rings, which, being connected to suitable points in the winding, give out three-phase alternating current; this is led back to the little three-phase trolley motor by three small conductors in the flexible cable, and so causes the latter to move along the wires at approximately the same rate as the vehicle on the road. An electro-magnetic brake is also fitted on the trolley motor, capable of being actuated at will by means of a sixth small wire in the flexible cable.

The pressure on the Vincennes route is 500 volts, supplied by the authorities, and no trouble is experienced with the insulation, either in the overhead equipment or the automobile.

The poles shown are wood, and therefore much larger in diameter than iron poles.

The flexible cable from car to line is always kept in tension by an automatic arrangement, irrespective of the relative positions of car and line.

The car is in the form of an omnibus, with a rear platform, so common in French vehicles of this class, and this omnibus is fitted up in a first-class manner, with solid rubber tyres to the wheels.

The weight of this car, empty, is 3 tons, and when loaded 5 tons. The car is propelled by a motor, capable of exerting a maximum of 15 H.P. at 500 volts, and the speeds are varied in the usual manner by a controller, which is a modified type of the tramway controller.

This omnibus is fitted up in a luxurious manner, and with motor equipment complete costs £640, but for ordinary use one with less expensive fittings is used.

A ride in this vehicle is as comfortable as in a private carriage, and certainly preferable to the ordinary tramcar.

The comparison between this system and the electric tramway resolves itself into:—

1. The cost of permanent way, both capital and maintenance.
2. The extra cost of current for operating automobiles on common roads on the system described.

The question of traction on rails *v.* common roads is one of resistance, and this varies so enormously under different conditions, that it is difficult to make a fair comparison.

The papers by Prof. Hele-Shaw and Mr. Brown, and the fact that the members have decided to form a committee to deal with this question, are indications of the traffic which is likely to take place on our common roads in the near future.

The views shown will, I hope, give you a clear idea of this system of electric traction, and in what manner it differs from the ordinary overhead systems.

The author next showed some views by the aid of the cinematograph.

The first showed a car coming along the road and steering clear of all other traffic in the same way as an independently driven car.

I have explained that where only a moderate service is required, it is not necessary to erect wires both sides of the roadway, and to allow two cars to pass, the plugs or connections have to be exchanged, and the next view (which is reproduced) will show this operation.

You will see the two drivers meet, and there is no difficulty in making this exchange, which is always effected at a stopping place, so that no time is lost in this operation.

If the service warrants the expense, overhead wires can be erected on both sides of the street, and with this extra overhead work it is not so unsightly as the ordinary overhead equipment, as the foregoing views have already shown. The exchange of connections is then, of course, unnecessary. Experiments have been successfully made with a new trolley, which will enable one set of overhead wires on one side of the road to operate cars in both directions, and this will save the cost of a double route.

This system is not yet, however, in practical use, and in busy thoroughfares it may be preferable to erect wires on each side, in order to better regulate the traffic.

This system opens up a wide field in every direction.

Where the ordinary overhead wires or the track in the roadway is objectionable, or the roadway is too narrow for a double line, this automobile trolley system can be used.

The numerous omnibus services that ply between railway stations and neighbouring towns can be efficiently replaced by such a system, and by building suitable cars, such a service, from its low initial cost, will prove more profitable than many intended "light railways."

For bringing produce, especially fruit, from Kent and other neighbouring counties to London, this system would be sufficiently elastic to meet such requirements, stopping where required to take up the goods.

This system is to be put down almost immediately in a town where omnibuses are now running, and I hope I may have the opportunity to lay the results before this Section in Glasgow.

---

### Discussion.

Major-General Webber: The points that occurred to me were especially with reference to the overhead part of the system at the poles and conductors, how far the inventor of this system would overcome the well-known difficulties as regards the interference with other electrical conductors following the same roads. Had he made any arrangement for that? Would the author state the distance, the length of the spans, the size of the wires, and the manner of insulating them, and how it was proposed to keep the conductors as nearly as possible within the same position horizontally?

Mr. Bnown asked whether Mr. Aldridge could give any particulars of the initial cost per mile, and if the system would be suitable for a tourist route on which there would be five or six 'buses each way over 20 miles in the summer and in the winter? What would be the initial cost for setting the whole apparatus? Tourist traffic was being developed a good deal in Ireland, and he was frequently asked about such matters.

Mr. Shoolbred said that the question of the mechanism of the travelling motor was of considerable importance. There were a great many other points of considerable importance, and it seemed at first sight undesirable to have a motor with such a thing as a transformation from three to two-phase system taking place there. Could it not be done in a less cumbrous way? The operations should be simplified by making them as few as possible. The question of the value of the application of this system was one of immense importance. The simple fact of dispensing with permanent way made the system interesting and ingenious. There appeared to be certain points with regard to the travelling carriage (which weighed 40 lbs.) being obliged to travel the whole length of the line, which formed considerable objection and which ought to be considered.

Mr. Sydney F. Walker said that they had to thank their friends in France for another advance in the traction of electromobiles. This apparatus was an amplification of a system running, he believed, on the Belgian canals at Charleroi. It appeared to him that it was the logical outcome of the development of traction to agricultural districts, but there were a great many difficulties in the way. In the first instance, as long as the horse remained on the road they kept the roads in a state of unevenness, because of his continual pounding. He made holes which increased the tractional resistance very much, and increased the vibration, and would particularly increase all the difficulties that lay in the way of such a system as this. As Mr. Shoolbred indicated, the flexible cable wanted very careful attention. He gathered that it had received it, and that there was not a great deal of strain upon it, but you could not get over the fact that they had six wires there; that they would have at certain times, at any rate, large differences of electric pressure between them; they might have large variations of differences of pressure giving rise to induction, and they had all the materials there for the deterioration of their insulation and sparking across, which was one of the greatest troubles electrical men had to deal with. He gathered that 15 H.P. was the maximum that the motor was capable of exerting. That was too small, he ventured to suggest. One of the greatest mistakes made in the introduction of electric motors for almost every new thing was that the power was almost always put too small. Under the circumstances, he should be inclined to put 50 H.P. They had all the trouble of carrying the weight of a 50-H.P. motor, and it introduced considerable financial and other difficulties in the way of the introduction of a new thing. The temptation was to cut the thing as low as they could, because cost was so much looked at; but if they put a 50-H.P. motor on that apparatus, they could be sure that it was always getting all the current it wanted; they need not be afraid of unevenness of road or other tractional difficulties. Although they had a 50-H.P. motor there, if they only wanted 5 H.P., the extra cost of running that 5 H.P. would be very small in comparison with the cost of possible breakdowns.

Mr. Alex. Siemens said that the author spoke as though the system was somewhat novel, but in 1879 Siemens & Halske ran the first electric tramway at an exhibition. They also ran a 'bus between Charlottenburg and Spandau on those very lines. They took current with the trolley system, which they had employed largely since in mines and large works with perfect success. He could understand Mr. Shoolbred objecting to the 40-lb. weight being carried overhead. He shared his objection, and thought that if a thick patch of india-rubber might be put on the motor it would lessen the blow when it fell!

Mr. Aldridge, replying, said that Major Webber asked questions as to the overhead equipment. He would like to point out that that line had been put up to some extent in a temporary manner to show what could be done in that way, and as much as possible ordinary tramway material was used. The insulators were turned up the other way, but they were very similar to the ordinary tramway insulators and connections which they saw every day. As to the question of the other neighbouring wires, so far as he was concerned, he had had nothing to do with other wires, for they had a clear roadway for two miles, and had no interference. Going through an ordinary thoroughfare they would have to take great precautions, because the 500 volts being across the two wires, as in the present system, they would have to take pains to prevent damage being done. In the outlying country districts there should be no difficulty in keeping clear of overhead telephone and telegraph lines, but in the crowded districts they would have to take extreme precautions. Mr. Shoolbred made some remarks about the little trolley. As he (Mr. Aldridge) explained, a trolley had been tried and found to answer which was much lighter, and the two trolleys had been so arranged that they passed each other. Undoubtedly as time went on that trolley would be improved. It was only the second or third made, and, therefore, there was every hope that they would have something lighter, and something which would not require india-rubber springs to obviate the damage in the fall. There were two lines in France, and they had never had the slightest trouble with the falling of the wires in any way. If this paper had been read years ago on the ordinary tramway system, there might have been many more objections made as to the possibility of the falling wires which did occur. Mr. Walker mentioned about the size of the motor, but 15 H.P. was

enough for the purpose. They could put one as big as they liked, but that was nothing to do with the system. The cable had given no trouble whatever. Mr. Siemens's remarks about a previous system of this sort he might expect, when he was connected with Germany and knew all that was going on. The German patent for this system had been granted, and there was sufficient novelty in it, or it would not have been granted in such a country as Germany. That was not a dragging trolley; it was a travelling connection, and nothing more.

## THE MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.

By Sir W. H. Preece, K.C.B., F.R.S.

(*Section G, September 10th.*)

A monorail line has been projected by Mr. Behr between Manchester and Liverpool to accommodate express passenger traffic alone between those two cities. It is to be worked by electric traction, and to attain very high speeds. The train is to consist of only one coach, weighing 45 tons, and seating 64 passengers. Starting at every 10 minutes, and travelling at the mean rate of 110 miles an hour, it will do the distance of 34½ miles in 20 minutes. The fares will be slightly lower than those charged at present.

There will be no intermediate stations, no points, nor crossings. There will thus be no necessity for signals to protect the line during other operations. Signals would be needed only to secure a perfect block system of working the line. The monorail railway was projected by Lartigue in 1882. We have only one example of this system of railway in the United Kingdom, viz., between Listowel and Ballybunion, in County Kerry, Ireland. This line was designed and engineered by Mr. Behr. The Act was obtained in 1887, and the line was opened for traffic in February, 1888, and it has been running ever since.

The line is 9¼ miles long. It has one intermediate station, Liselton. There are 42 level and farm crossings. It is worked by steam. The train consists of a locomotive and four coaches. It cost £33,000 to build, or £3,060 per mile. When I inspected the line in the early part of this year there had never been a Board of Trade inquiry into any accident. The maintenance of the structure had been effective. No rail had ever been turned. The mechanical structure had exhibited no defects, but several breakdowns had occurred in the locomotive and rolling stock. There are three locomotives, eleven passenger coaches, and two brake vans. They had, however, continued to work the line uninterruptedly for 12 years, and there had been no renewals or new stock.

Its main principle is the suspension of the coaches on a single elevated rail so that their centres of gravity are below the rail. Each coach sits the rail like a saddle. The rail is fixed on trestles which are tied and braced together, the tie bars being light rails against which guide wheels roll.

The Manchester and Liverpool Express is intended to be more massively and rigidly built. Derailment on such a structure is impossible, and curves of comparatively small radius can be passed with safety at high speeds. Vibrations and noise will be reduced, and travelling will be conducted with greater comfort than at present.

It is proposed to fix the generating station midway at Warrington, and to transmit the electric energy at high pressure (10,000 volts) to each terminal station. There would be sub-stations along the line at distances apart of four miles where the 10,000 volts would be brought down to 1,000, at which pressure it would be picked up by the motors on the coach.

The speed which a train can acquire on a railway depends on the power that can be continuously applied at the tread of the driving wheel. Electricity enables the engineer to apply instantaneously to light loads a power which steam cannot supply. Hence speeds are possible with electricity which are unattainable with steam. A coach weighing 45 tons can easily and quickly attain 110 miles an hour. 1,600 H.P. will accelerate the coach so as to attain this speed in 110 seconds, and 500 H.P. will maintain this speed on the level. Electricity has two advantages over steam. It enables us to obtain an acceleration of 1½ feet per second, which is virtually the limit that can be obtained without causing discomfort to the passengers, and secondly, it applies a continuous and constant torque, instead of the variable one due to the reciprocating action of the ordinary steam locomotive. Hence it not only enables us to maintain high speeds on long through lines like the proposed Manchester and Liverpool Express, but it enables us to attain high speeds with greater rapidity on short lines having frequent stoppages, like the Metropolitan Railways of London, and thus increase the capacity of the line for traffic.

The chief causes of accident on ordinary railways, viz., collision, derailment, points, and the human error of the signalman, will be removed from the lines. Hence travelling will be much safer.

As regards accidents on railways. They are generally due to collision. There can be no collision where there is only one train. While the one train is running between Liverpool and Warrington, it is a mono-train railway. But, supposing the traffic increases, it is an easy thing to break up your section into blocks of a little over four miles, while maintaining absolute security, because the way of working is not to put up outside visible signals to control the driver of the train, but to cut off the current. When a train has gone it cuts off the section of four miles behind it, and makes the whole system dead, and the moment the second train comes within four miles of the first, it stops, and there can be no collision. Ninety per cent. of the railway accidents are due to the faults of human beings, but in the Manchester—Liverpool system the human element is at a minimum.

Mr. Behr has prepared a short paper on brakes and signals, which he will now read.

## MANCHESTER AND LIVERPOOL RAILWAYS; BRAKES AND SIGNALS.

By F. J. Behr.

(*Section G, September 10th.*)

The question of brakes and signals are so intimately connected that the one cannot be treated separately from the other.

The most perfect condition under which a railway could be worked, would be that in which both brakes and signals could be dispensed with, therefore it follows that the fewer the occasions for using either, the better.

Now as to brakes, there is a limitation of their application, which depends not so much on the mechanical appliances themselves as on the endurance of the human bodies in the trains. It was stated by an eminent railway official that with the Westinghouse brake, a train travelling at 60 miles an hour could be stopped, as an emergency brake, within 360 yards without inflicting too great a shock on the passengers. In the same way, a train travelling at 110 miles an hour could be stopped within 500 yards, and probably in a shorter distance, as in the latter case electrical means are at hand, such as the reversal of the motors, so as to turn them into dynamos. More rapid stoppage could only be made with great discomfort to the passengers. Now in the ordinary way of working our railways at present, there are many occasions in which it might be important to stop the train as rapidly as possible. For instance, if a train in front should be seen, or some shunting operations not yet completed, or many others too many to enumerate, but no brake, however powerful, would be of the slightest use to-day to avoid a sudden obstacle, such as a stone placed on the rail, or a broken rail, for it is impossible for the driver to be aware of such obstacles until he is practically upon them. For these cases of great emergency, therefore, the stoppage at 300, or 200, or even 100 yards is quite useless.

What I wish to show now is, that on the proposed high-speed electrical railways, though it is quite possible to brake the train within less than 500 yards, it never can be necessary to bring it to a standstill at even a much longer distance.

On the proposed railway there are no level crossings, no switches, no shunting operations, and, in fact, nothing that will require the train to be brought to a standstill, except in the event that a preceding train should break down. Besides this one case, the brakes can only be used for stopping as you approach the stations. A broken rail offers no danger in this case whatever, for the train would run over it without any danger or difficulty. This can easily be shown by carefully considering the relative position of the wheels in the carriages to the rails over which they travel.

I now, therefore, have only to explain the manner in which it is arranged that the driver of each train shall be informed of the possible stoppage of the train in front of him.

No second train will leave the station at Manchester or Liverpool until the first has reached Warrington, a distance of just 17 miles.

We sub-divide the line for the purpose of signalling into eight sections of 4·3 miles each. As trains leave Manchester station a danger signal is put up automatically at that station, a second similar danger signal is put up in the same way at 4·3 miles off, the first remaining at danger. The train travels on until it reaches 8·6 miles, when it puts up a third danger signal, and simultaneously the signal is lowered at Manchester or Liverpool station, so that the second train can leave when the time comes.

Now, we will assume that the first train has met with an accident after passing point 8·6 miles, the second train would travel at a higher speed right on, but when it passes point 4·3 miles, the danger signal at that point not having been removed by the first train, as this never reached point 13 miles, the driver of the second train would be informed that the first train had met with an accident beyond 8·6 miles, and therefore that he had to slow down, but that for such lowering of his speed he had a clear run of over four miles. Therefore, there could be no difficulty in any case to stop even without using the brake at all, by simply cutting off the current.

Whenever a train passes over a point where the danger signal is put up this is also produced, either electrically or mechanically, by a very simple and inexpensive contrivance in the cabin of the electrician, so that he should be perfectly able to see it without difficulty even if there was a thick fog.

Under these conditions of travelling, it seems, therefore, superfluous to have any emergency brakes, and though we shall be able to stop the trains within 500 yards, no case can be imagined in which it would be useful or necessary to resort to such a stoppage.

A six minutes' service of trains can be established without any alteration in the proposed arrangement, and if a three minutes' service was required, the blocks would have to be reduced to two-mile sections, giving a clear run of two miles in case of a breakdown.

### Discussion.

Mr. Shoolbred said that Sir W. Preece mentioned that the principal causes of the postponement or the throwing out of the

Bill were due to the opposition of the Mersey Docks Board and the Salford Corporation. Might he ask, as an outsider, whether the committee did not appear to be hardly satisfied on the question of the speed, and the efficiency of the brakes at that speed? It was apparently on that point that they wished for further information to be provided, so that the committee that eventually dealt with the Bill could be quite assured that the public would be travelling in safety. One of the points said to be raised before the committee, was the question not merely of speed and brakes, but also as a secondary question, that of the air friction, which it was said that the train might expect to encounter. A short time afterwards he happened to note the result of some experiments lately carried out in the States, where they attempted to find out the result of the air which found its way eddying in the space left between the carriages themselves. They had considered the question of the conical form of the engine, whether it shall be like the ram of a vessel. He thought there was a considerable reduction (about 40 per cent.) of the air friction by simply boarding up those spaces or interstices between the carriages. Perhaps Sir William could give them some more correct results as to experiments since carried out, as that point was of considerable importance in connection with the travelling of the train. The Brussels Railway seemed to be the only one working, and it was calculated from that what might take place at 100 to 110 miles an hour. Committees were cautious about accepting theories, and they preferred accepting facts instead. Mr. Behr mentioned that the rolling stock weight was 50 tons with its motors, and its carriage length about 55 feet. Compare that with the weight of the present passenger carriage, long Pullman saloons, two and three bogey, whose average was somewhere about 20 tons. Were they to pay that heavy price of doubling the weight of the train? If they were to increase the weight to 50 tons, how many of the carriages——

Sir W. H. Preece asked if the speaker had realised that the weight of the train, which consisted of one coach containing motors and passengers and everything complete, was only 45 tons. There was nothing else to be added to it.

Mr. Shoolbred asked how many of those 45-ton units would be required to counterbalance the first class train at the present moment? What was the gross weight per passenger carried?

Mr. Behr: Sixty-four passengers; 12 cwt. per passenger. On the South-Eastern Railway corridor trains the weight per passenger was 1¼ tons.

Mr. Shoolbred asked whether the drawing of the motor shown on the screen was the one intended to be used on the Liverpool line. At the very speed at which it was proposed to travel, was it not likely that there would be considerable friction and abrasion in the inside teeth?

Mr. S. F. Walker said that this system was one of the instances of the superiority of electrical distribution over ordinary locomotion. The real question was not the weight per passenger, but the carrying capacity per passenger. He referred to the progress now being made by the polyphase system in this country. Prof. Carus-Wilson pointed out recently that the polyphase motor had many advantages over the ordinary continuous current motor, particularly that of having no commutator to bother with. On the Liverpool line it was proposed to use 1,000 volts. A little while ago they would have considered that a serious matter. We had become accustomed to 500 volts in the streets and nothing particular had happened, but 1,000 volts was a little bit high. He proceeded to refer to a dispute between one of the directors of the electrical railways in Switzerland and the French Government, and the experiments performed by Weber with alternating currents applied to his own person.

Mr. F. B. Behr, in replying, said, with regard to the Parliamentary proceedings, there was an observation made on the brake, but it was stated that it had not been sufficiently explained to them whether the brake power was sufficient. The paper he had read was really read with the intention of explaining to the future committee that point which they missed last time. Ostensibly they said that they refused to pass the Bill, because they said that they might have avoided taking a piece of the Dock Board's estate in Liverpool, and that they might have satisfied the Salford Corporation by going in a tunnel instead of a viaduct. There was no question before the Committee about the friction of air, therefore that matter did not come up. The Board of Trade were the proper authorities for safeguarding the public, and they would be very careful not to allow those trains to be run until they were safety itself. The Committee did not go into the details of the safety of passengers. It was entirely a matter for the Board of Trade. The motor shown was not the one proposed to be employed, but it was constructed for the Brussels experiments by Messrs. Parker. That motor acted successfully, and the chain acted during 18 months so satisfactorily, that they never had once to shorten the link, and the teeth were there for inspection. The chains acted contrary to the expectations of many people. At Brussels they ran up to a speed of 85 miles an hour. With regard to the volts, he forgot to say that the Brussels experiment was worked at 750 volts, therefore to do it at 1,000 volts was only one step in advance. Having run there at 750 volts without difficulty, he thought they might as well try to do 1,000 volts. He tried in the whole design to avoid as much as possible every cause of danger. One of the causes was, no doubt, coupling, and he thought that at such speeds it would not be safe to run coupled carriages. Therefore, to run the system economically by electricity they had to run very frequent and light trains. The London & North-Western Railway ran two express trains to Scotland per day, weighing each 450 to 500 tons, in the morning and the evening. He thought if, instead of that, they ran 20, and every 10 minutes or half an hour, according to the public want, they probably would carry more passengers and accommodate the public much better. The economy was not only the time of travelling, but in waiting for the train. In designing the Liverpool service, they designed it for a 10 minutes' service. With one carriage weighing 45 tons, and carrying 64 passengers, they would carry about 7,500 passengers per day. The idea was ridiculed that there was to be such a number carried. The whole three existing railways together said that they only carried 1,500. Mr. Behr had them counted, and found that they carried 4,000, but they would not produce their books. They proved to the Committee that they really lost by their service! They proved that they carried the service at a dead loss of £200,000. Mr. Behr said that the traffic between any great towns could not be the criterion of what the traffic would be at increased speed. They could carry more by small trains at frequent intervals, whatever the other lines carried. The cost was such, that they produced before the House of Commons Committee a calculation that they could pay a dividend of 15 per cent. on the share capital without raising the prices, but charging slightly less than the existing railway companies with a traffic of 4,000 passengers per day. As to the centre of gravity, in the design of the coach of the Liverpool railway, it was about 15 inches below the top of the carrying rail, therefore it was a stable equilibrium.

Sir W. H. Preece, also replying, said that the dual capacity of the paper that day was due to the fact that originally he undertook to read it. Mr. Behr was expected to go to Russia, but as he had not gone, he (the speaker) thought it would be interesting to the section to bring him down personally. He had answered most of the questions, but one he had not, and that was regarding the question of danger. Mr. Walker had referred to some experiments recently undertaken by Prof. Weber, and he was inclined to think that there were a good many misprints in the report that they had seen in the press. He spoke of being paralysed with 50 volts. If he had said 500 volts there might have been something in it. He (Sir William) had not been paralysed with 2,000 volts. He had been very uncomfortable, and did not want to undergo the ordeal again, but he was not paralysed. Different individuals were differently sensitive to the effects of voltage. It was not voltage that they had to fear so much; it was the flow of current through us. It was current that killed, and if their hands were in a dry state they might often handle 20,000 or 30,000 volts. Everyone of them could experiment with Röntgen rays and frequently get shocks from those coils. They did not hurt them because their hands were in a dry state; the body offered a very large resistance and very little current went through; they could handle large voltages with impunity. But if they wetted their hands and the resistance ran down from 1,000's to 100's or 10's, no doubt they would feel shocks. He did not think the most sensitive person would be paralysed with 50 volts. There was almost a consensus of opinion all over the world that 500 volts was the proper voltage for tramways, because there is no record of a person being seriously damaged by 500 volts. 750 volts would be used in some places.

---

## ON THE APPARENT EMISSION OF CATHODE RAYS FROM AN ELECTRODE AT ZERO POTENTIAL.

By Charles E. S. Phillips.

(*Section A, September 8th.*)

It has been noticed by many people who work with X ray or other vacuum bulbs that numerous bright green patches occasionally appear upon the inner surface of the glass walls of a bulb while a discharge is passing, especially during the process of exhaustion.

These green flecks vary considerably from time to time both in shape as well as in position, and efforts have been made to connect their existence either with want of uniformity in the composition of the glass or with irregularities in the surface of the negative electrode.

I have already, in another place,* given some account of an experiment made with the object of clearing up this uncertainty, and now beg to supplement that work with the following observations as to the cause of the phenomenon. The experiment just referred to consisted in using a pivoted disc of aluminium as the negative electrode in a bulb containing rarefied air, so that when green patches appeared a rotational movement of the disc (actuated by means of an external magnet) would show whether the patches of green moved in a corresponding manner or not. It was seen that they did so move.

A distinct feature of the experiment, however, consisted in ascertaining whether those flecks which persisted after the discharge had ceased were still sensitive to movements of the cathode. This also was found to be the case. The proof, therefore, that the green patches were associated with an emission from the cathode appeared complete.

But it was further noticed that subsequent to the passage of a discharge, and even when either or both of the electrodes were connected to earth, still the green flecks were easily visible upon the glass walls of the bulb, and continued to move as before when the cathode was rotated.

This was apparently a case in which cathode rays were emitted from an electrode at zero potential.

I do not know that any explanation of this effect has so far been offered, and I therefore venture to bring forward the following suggestions, supported by further experiments.

When a piece of metal is placed in a rarefied atmosphere, and made the negative pole for an electrical discharge passing across the

* *Electrician*, 41, 1898, pp. 425-426.

attenuated gas, innumerable small bright specks of light appear over the surface of the metal. It was found convenient in my particular case to use an *iron* electrode for observations of this effect, because it had the advantage of being readily magnetisable from without. The addition of a similar iron electrode to act as the anode determined the shape of the magnetic field. With such an apparatus it could be seen that the bright spots appeared principally upon the *cathode* while the discharge passed, and that the creation of a magnetic field between the electrodes made visible the individual luminous streams of gas emanating from those tiny points of light. The paths of these luminous streams, becoming bent by the action of the magnetic field, followed the direction of the lines of magnetic force, and exhibited a tendency to become spiral in accordance with well-known laws. In this way a fine layer of sodium upon the anode was caused to fluoresce through the action of the negatively electrified particles beating down upon it. One was able, in fact, by this means to cast shadows of objects placed in the paths of the bent streams, and at a pressure considerably higher than that necessary for the production of the well-known cathode shadow effects. In the above case, however, the method served to clearly establish the fact that the bright points of light upon the surface of the cathode indicated the places from which the jets of gas originated.

The number of these jets became less as the exhaustion was continued, and individual streams were very clearly seen owing to the action of the magnetic field. When the discharge began to cause fluorescence in the glass of the bulb some green patches made their appearance, and, in some cases, when the cathode was magnetised a bright spot, which was previously judged to indicate the origin of a green patch upon the glass, would shift to a new position upon the electrode. In all such cases the corresponding patch also moved in a similar manner upon the glass.

At sufficiently high exhaustions the bright spots upon the electrode disappeared entirely, although green flecks were still visible upon the glass. But a movement as before of the electrode, as well as its magnetisation gave results consistent with previous observations.

Under these conditions, when the discharge through the bulb was stopped, green flecks were still visible for about 10 seconds.

A positively charged body was brought up to the outside of the bulb, and the patches brightened considerably. A negative charge similarly placed extinguished the flecks completely. This was also the case when the electrodes were connected to earth.

Finally, vacuum bulbs, such as X ray lamps, &c., exhibiting green flecks while in operation, were generally found to deteriorate if laid aside for a month or two, owing to an increase in the pressure of the contained gas. We see, therefore, that, in the first place, the bright points of light upon the surface of the cathode are due to the emission of fine jets of gas; also that such jets, if negatively charged, may be made to cast shadows of objects suitably placed in their paths. It is at the same time clear that the green flecks referred to above are due, during the passage of a discharge, to these same jets of gas impinging upon the inner side of the glass walls, and that, under the conditions existing immediately subsequent to the passage of the discharge, it is evident that streams of gas continue to be emitted from the pores of the electrodes. In spite of the fact that with the electrodes connected to earth these streams consist of unelectrified particles, they assume that property of ionisation during their passage across the space within the bulb which appears to be essential to the production of local fluorescence in the glass upon which they impinge.

This latter effect, while explaining the process by which a cathode emission may appear to originate at an electrode with no electrical charge upon it, is one to which I wish to draw especial attention, for there is reason to believe that the upper limit of speed for the individual particles constituting the jets cannot exceed the rate at which sound is propagated.

It is therefore interesting to find that, under such circumstances, fluorescence was produced in the glass upon which the streams impinged.

As many of the observations referred to here were made during the course of an investigation into the diselectrifying action of magnetism now being carried out by myself at the Davy-Faraday laboratory of the Royal Institution, I desire to express my indebtedness to the managers of that Institution for the facilities which they have kindly placed at my disposal.

---

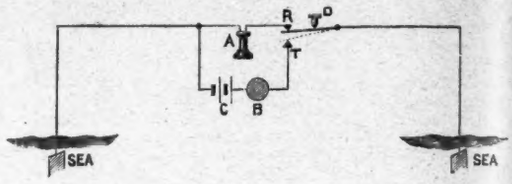
## WIRELESS TELEPHONY.

By Sir William Henry Preece, K.C.B., F.R.S.

(*Section G, September 10th.*)

The first experiments in this direction were made in the month of February, 1894, across Loch Ness in the Highlands. On that occasion trials were made to determine the laws governing the transmission of Morse signals by an electro-magnetic method of wireless telegraphy, which has formed the subject of frequent reports to this Section since 1884; two parallel wires well earthed were taken, one on each side of the lake, and arrangements were made by means of which the wires could be systematically shortened with a view of ascertaining the minimum length necessary to record satisfactory signals. It occurred to Mr. Gavey, who was experimenting, to compare telephonic with telegraphic signals, *i.e.*, to ascertain whether articulate speech could be maintained under the same conditions as Morse signalling. The trials showed that it was possible to exchange speech across the Loch at an average distance of 1·3 mile between the parallel wires when the length of the wires themselves was reduced to four miles on each side of the water.

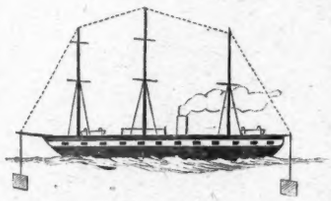
What led to this train of thought was the fact that although the volume of telegraphic current was immensely greater than that of a telephonic current, whenever, through want of balance as a loop, disturbance was evident, then telephonic cross-talk was also manifest. In other words, a weak telephonic current was apparently as powerful a disturber as a strong telegraphic one.




A, Telephone receiver (60Ω).
B, Deckert transmitter.
C, 10 Obach dry cells (14 volts).
D, Press button on A to move switch from R (receiving) to T (transmitting). Transmitting current ·5 ampere.

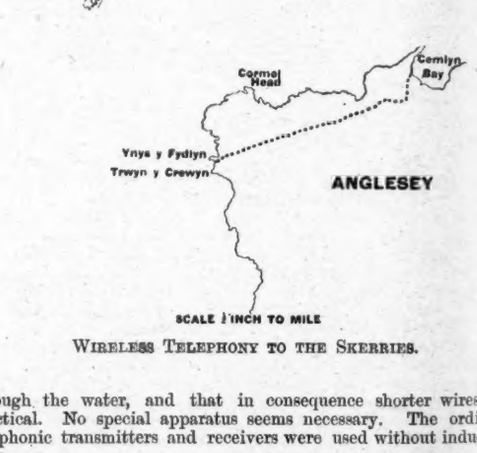
Diagram of Connections.

The sensation created in 1897 by Mr. Marconi's application of Hertzian waves distracted attention from the more practical and older method. Mr. Evershed and Principal Oliver Lodge had in the meantime much advanced the system by introducing admirable call systems.



Wireless Telephony at Sea.

In 1899 I conducted some careful experiments on the Menai Straits which determined the fact that the maximum effects with telephones are produced when the parallel wires are terminated by earth plates in the sea itself. It became quite evident that the ordinary inductive effects are much enhanced by conductive effects through the water, and that in consequence shorter wires are practical. No special apparatus seems necessary. The ordinary telephonic transmitters and receivers were used without induction coils.

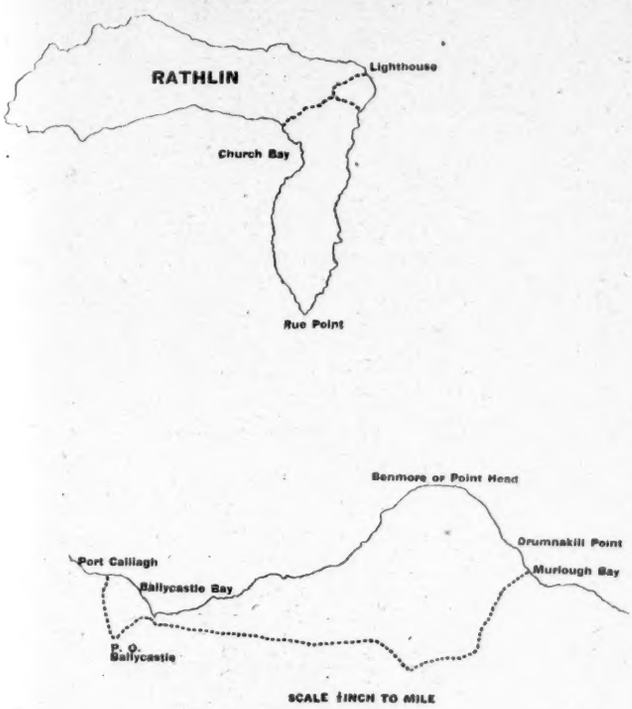



Wireless Telephony to the Skerries.

It became desirable to establish communication between the islands or rocks known as the Skerries and the mainland of Anglesey, and it was determined to do this by means of wireless telephony. The lighthouse at the Skerries was wanted to be in communication with the coastguard station at Cemlyn. A wire 750 yards in length was erected along the Skerries, and on the mainland one of 3½ miles from a point opposite the Skerries to Cemlyn. Each line terminates by an earth plate in the sea. The average distance between the parallel portions of the two wires is 2·8 miles. Telephonic communication is readily maintained and the service is a good one.

Further experiments with wireless telephony have recently been made by Mr. Gavey, between Rathlin Island, on the north coast of Ireland, and the mainland. The east and west portions of the island of Rathlin are about 8 miles from the mainland, but a tongue of land projects southwards to within a distance of 4 miles. Communication was required between the lighthouse near the north-eastern corner of the island and the mainland, and the question for

solution was whether an overhead line running the whole length of the island from east to west was necessary, to obtain good communication, or whether a shorter line across the neck of the southern peninsula would serve. The preliminary experiments that have been made prove conclusively that communication, both telegraphic and telephonic, has been readily maintained by means of temporary




Experiments at Rathlin Island.

wires established across the neck of the peninsula along the shorter line. Wireless telegraphy across the sea is now a practical and commercial system.

No experiments have yet been made with ships, but it would appear simple to speak by telephone between ship and ship or between ship and shore to considerable distances, by means of a circuit formed of copper wire passing over the top-masts and terminating at each end of the ship in the sea, using simple telephones.

---

### Discussion.

Dr. Larmor said that they could corroborate Sir William on the extreme simplicity of the arrangements described. He, personally, was not competent to say anything about those practical matters, but he saw present the man who was the pioneer in the new departure in telegraphy across space. Others of them who were at the B.A. at Oxford four or five years ago were probably surprised at Prof. Lodge suddenly coming forward with a complete system of wireless telegraphy. The things he had on the table and what he did were quite enough to convince anyone that the system was practical and had only to be developed.

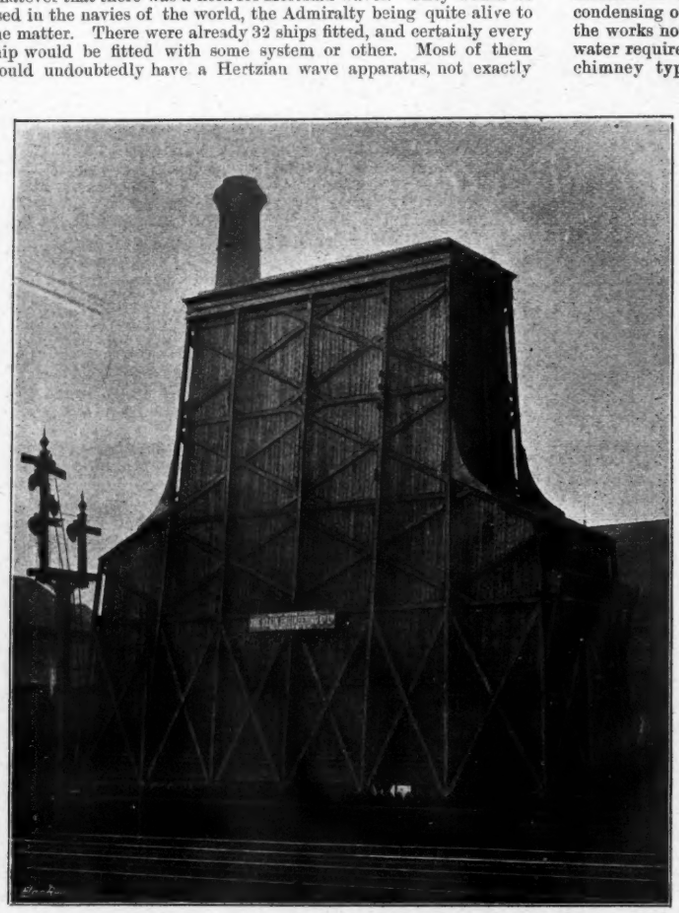
Dr. Oliver Lodge said he had been much interested in those trials of Sir William Preece's, and had from time to time had something to say about them. He had always urged that the earth tapping, the sea conduction, was really a more important factor than the induction between the wires, although the two helped and went in the same direction. In some cases it might be possible that the induction was the more powerful. At any rate, with induction they could get up stronger currents and could have tuning better developed and so on, and they could have the principle of resonance developed better than with the conduction of the sea. With the two terminals in the earth for the sender and the two in the sea for the receiver he had had communication between the College and his house and could signal from end to end. He believed in the sea one could do better. One reason why the telephone and high frequency currents were so efficient in this matter was because they did not spread through three dimensions. The conductivity of the earth was sufficient to keep high frequency currents fairly to the surface so that they only spread in two dimensions, and that gave a tremendous advantage, indeed, made it possible, he believed, to signal over enormous terrestrial distances if ever it were wanted to do so. The call which Sir William Preece spoke of depended upon the magnifying principle, using the received current to actuate a microphone and a magnified current to operate another until you got something which would give any amount of energy required, so that the energy of the final signal did not depend at all upon the energy of the received current. All that the received current had to do was to liberate the trigger as it were, and they could have any amount of energy they might wish. Recently they had been using a Morse instrument giving regular dots and dashes, working with received currents which were not exactly too weak to be heard in the telephone but too weak to be employed for signalling purposes. If they had to be so employed it would mean telephone to each ear, a very attentive observer, and an absolutely silent room. They might be able to make out the long and short signals with that kind of received stimulus; it might be possible to work the Morse instruments and get regular signals. That seemed to show that that process had a considerable future before it, especially from what Sir W. Preece now found, and what he was not altogether unprepared to believe, that they could actually get the currents strong enough over very fair distances to be heard as speech. There were difficulties about earth currents which were felt the most when they tried to record, unless they took pains to eliminate them, as he (Dr. Lodge) did by tuning. The ear easily discriminated between what it was intended to hear and what it was not intended to hear. They could discriminate articulate speech from earth currents and other disturbances, which were sometimes pretty bad. Sir William spoke as if the Hertzian wave method was superseded. That was a practical question on which he was able to judge. He should have thought that there was one case for which one method might be more suitable and another for another. He should think some modification of both might be sometimes convenient. There were places for a lighthouse where they could not get a good base line. He did not know how far a ship would like to have those plates immersed in the sea, and the conductivity of the iron — of which most ships are built nowadays—also occurred to him. Lightships which had not to go ought to be made of wood because it was warmer and more comfortable to live in. If made of iron he should have thought there would be trouble. If they dispensed with the earth conduction, and used conduction dispensing with that ornamental arch, then they could do it, but he did not know what naval people would think about those earth plates.

Mr. Sydney F. Walker said that he was working in that field in 1892, and in 1893 Sir William Preece and Mr. Gavey had communication with him on the experiments he had made. He took up the problem where Sir William had left off. His object was to find a means of communication between ships, and he attacked the problem in the proper scientific way that invention is now carried out upon. He measured the smallest pressure that the ordinary telephone receiver would work with, and he found it was the thousandth of a volt. He proceeded to build the thing up. Eventually they succeeded in sending spoken words, by telephonic transmission, across the Taff at Llandaff Bridge, about 100 yards wide. He dropped it there because he could see nothing in it. He communicated with Sir William, who sent him to Mr. Gavey, and by his instructions he provisionally protected the apparatus, and then he was told that it was better to run a cable across to any lighthouse where it was wanted. In the course of the work he cleared, he thought, a good bit of the ground. He published the whole description in the *Electrical Engineer* at the end of 1892 or 1893. The law governing his experiments was that if you have a source of current of infinitely low resistance, practically infinite capacity for turning out current, you could transmit to an infinite distance. If you could have a base line infinitely long you are in the same position; if you can have plates infinitely large—he thought members would see what he was driving at. You got your source of current of low resistance, that was to say, you had a current which you were turning out as large in quantity as you desired, or to put it the other way, you got your base lines as long as you could; you got your plates as large as you could, and you made up by the amount of current you turned out; but he thought there were some points against it. His view with regard to the matter agreed with Prof. Lodge's. There would be undoubtedly certain cases such as Sir William had attacked, which would be worked much better on the purely conductive system, though they would have induction effects as well on the plates. As to the question of ship to ship and ship to shore, he agreed with Prof. Lodge that that would be much better attacked by the inductive system. He would be glad to hear what Sir Wm. Preece had to say in reply. It appeared to him that the whole telephonic system through space either inductively through the sea or conductively through the ground or sea was subject to one great objection, that anybody else who dropped in a pair of conductors with an apparatus attached to them could read your message.

Mr. Julius West, of Berlin, said that in using this system of communication between ships they did not say whether the positions of the two ships were right angular to each other. He had been carrying out near Berlin, with Mr. Rathenau, some experiments in wireless telegraphy on Sir William's old system. They tried to find out whether electro-magnetic induction or conductivity was the reason for the transmission. They had one station on land and one out at sea; they had two small launches connected together and tried to make those experiments. They had one launch anchored and went round with the other and found that they did not get any communication at all when the two lines were at

right angles to each other. He did not think they would get any further results with wireless telephony in that case.

After others had also spoken, Sir W. H. Preece replied. He said he felt a little ashamed of bringing before Section A, devoted so much to the deepest branches of science, a subject that was of a rather more popular character. The only excuse was that it was brimful of the very facts and ideas that formed the subject of Prof. Larmor's address to the Section. For instance, the question of the apparent similarity of the quality of those disturbances arising from heavy telegraphic currents and those arising from currents of a very high frequency. It was quite clear that it was the time element, the time constant, the rate at which the current ascends, rather than the intensity of the current which gave the effect, and they all knew that that time constant was one that depended directly upon the amount of inductance in the circuit, and the amount of capacity. All his efforts had been to remove from the circuit entirely every element of self-induction. The coefficients of self-induction in the circuits that he had drawn upon the board were all, he might say, equal to nothing, they were so small that they might be eliminated. By reducing the third element, resistance, they had without self-induction, without capacity, and with the least possible resistance, their maximum effects, and they got effects from telephonic currents as intense apparently to the ear as from the telegraph, and greater than the effects produced by those great currents transmitted for power, which might go up to hundreds of amperes. Those currents produced no disturbances on a telephone. In all your experiments remove what we know so well as L, get rid of K, and have C R as small as you please, and you get all the conditions to speak across space. As regarded Prof. Lodge's remarks—he had been in almost intimate relationship and consultation for several years past with Principal Lodge. All those experiments that he had conducted had been done with Dr. Lodge's knowledge; he had been with him in Wales at the experiments at Menai Bridge. He referred to the question of resonance and tuning. He thought the elimination of those three points rather than resonance of any kind improved matters and rendered tuning unnecessary. There was nobody who had worked so hard in that field as Prof. Lodge, and all he (Sir William) knew about Hertzian waves he was indebted to him for. There was no doubt whatever that there was a field for Hertzian waves. They would be used in the navies of the world, the Admiralty being quite alive to the matter. There were already 32 ships fitted, and certainly every ship would be fitted with some system or other. Most of them would undoubtedly have a Hertzian wave apparatus, not exactly Marconi's, because it happened that in the Admiralty a very distinguished naval officer, Captain Jackson, was experimenting for the Navy before Mr. Marconi came to this country, and all his reports were confidential. They were not reported and he had not obtained the credit, because publication alone allotted due credit to a man for his discoveries. Capt. Jackson had worked very hard and was placed by the Admiralty in charge of that department. Questions had been asked with reference to thunderstorms. On this point he said that you never could use a telephone in a thunderstorm if your circuit was defective, or if you used the earth with one wire without knowing there is a thunderstorm somewhere near. In the first telephones he remembered well, when they opened the circuit from London to Paris, they had a grand display at the Post Office. Postmaster-General Raikes gave an "at home" in his room and every now and then they were startled by something like the crack of a pistol. It was a thunderstorm in France reproduced in the telephone in the London Post Office. That would always happen in a telephone system if the circuit was not complete, unless it was made of a metallic circuit and those two wires were twisted round each other. If they had two wires and got rid of the earth they might laugh at lightning. In experimenting between Dover and Boulogne with Marconi's apparatus a very severe thunderstorm came on; Mr. Gavey, who since 1882 had carried out all experiments (there was scarcely a year without a report from him on their experiments), was at Dover and saw there was a thunderstorm near; he thought it was possible to communicate with Boulogne, and without a word to Marconi or anybody there commenced to signal to Boulogne and then reverted to the instrument and asked if they had read what was sent. The Frenchman could not read it because it was not language, but he could read the signals made in that surreptitious manner by Mr. Gavey, when the atmospheric effects made marks to record themselves in Boulogne. It was quite possible with atmospheric electricity to signal across space if they had the atmospheric electricity at their own end.



Cooling Plant at Oldham.

## COOLING PLANT AT OLDHAM.

We illustrate below a Klein's cooling plant recently erected at Oldham electricity station, to deal with the condensing water required for about 1,800 H.P. from Willans engines. Previous to the erection of the cooler, these engines had been worked non-condensing owing to lack of water, the small pond in existence at the works not being of sufficient capacity to cool the amount of water required. The cooler is of the well-known Klein's patent chimney type erected over a pond on steel girders. The framing is of the best pitch pine.

The temperature of the water after leaving the cooler is 60° F., which is an exceptionally satisfactory result, and is obtained without any power being expended in driving fans. There is only a small amount of evaporation, as a large portion of the vapour is condensed before it escapes from the top of the chimney, which is of sufficient height to carry off the vapour so that no nuisance is created in the neighbourhood.

Since the Klein cooler has been erected and the condensing plant put in operation, it has been found possible to dispense with one out of four boilers, equal to a net saving of 25 per cent.

## ELECTRIC SUPPLY MAINS.

The following is a copy of the Cable-Makers' Circular referred to in our other columns this week:—

The terms and conditions in contracts for electric mains and details of conductors have varied so much in different specifications, that, with a view to standardisation, the undermentioned cable makers have drawn up the following, which they suggest as a basis for tenders.

1. *Conductors.*—The sizes and combinations of conductors shown on the accompanying table to be adopted.

2. *Guarantee.*—If a guarantee be requirsd for cables supplied and laid by the contractors, such guarantee to be in the form of an undertaking to make good any fault due to defective material or workmanship, and to be free for a period not exceeding 12 months after the cables are laid In case it should be desired that this guarantee be extended beyond 12 months, an annual charge to be made.

In cases where cables are supplied by the contractor, but are not laid by him, the term of guarantee (if any) to date from the time of delivery of the cables.

Should the contractor be required under the guarantee to locate and repair any defect which may occur in the cables, a charge for such work to be made by the contractors in all cases where there is no proof that the defect was caused by bad material or workmanship.

A contract for maintenance when required to be considered as a separate matter from the guarantee and to be charged for accordingly.

3. *Quantities.*—In the case of a yearly supply of cable, the approxi-

mate quantities are to be stated, and the contractor shall not be called upon to deliver more than 25 per cent. in excess of these quantities, or less than 25 per cent. below them without special arrangements as to price being made.

4. *Disputes.*—The engineer's decision shall not be considered as final, but there shall be an arbitration clause.

5. *Duplicates of Specifications.*—Specifications shall be supplied in duplicate to all firms tendering.

6. *Suspension of Works.*—The purchaser shall pay to the contractor all reasonable expenses arising from suspension of works by the engineer, unless such suspension be due to any fault on the part of the contractor.

7. *Payment.*—In contracts for the supply and laying of cables, payment to be made on terms not less favourable to the contractor than 80 per cent. on monthly certificates, 10 per cent. on completion or putting to work (the completion or putting to work not to be dependent on any other contractor), the remaining 10 per cent. twelve months after completion.

In the case of cables supplied by the contractor, but not laid by him, payment in full to be made within one month from date of engineer's certificate of each delivery.

8. *Engineer's Certificates.*—The engineer shall certify for payment within 14 days of presentation of the account, and the purchaser shall make payment within one month from date of certificate.

In the event of there being any dispute as to the account, or any claim in connection with the work, the engineer may deduct from the account rendered such reasonable sum as may be necessary to cover the work in dispute; but the issuing of the certificate shall not be delayed in consequence.

Failing payments as specified in clause 7, and this clause, the purchaser shall pay interest at the rate of not less than 5 per cent. per annum.

9. *Tests.*—Current for tests on site shall be supplied free to the contractors at the tension of the ordinary supply.

10. *Extras.*—The contractor shall not be called upon to supply without payment any materials or work not detailed in the specification.

11. *Packages.*—Where cables are supplied but not laid by the makers, the drums containing them shall be charged for, and allowed for in full when returned, carriage paid, in good condition within three months. If returned later, not more than two-thirds to be allowed.

The following cable makers have agreed to these terms and sizes of conductors to take effect on and after October 1st, 1900:—British Insulated Wire Company, Limited; Callender's Cable and Construction Company, Limited; Connolly Brothers, Limited; Henley's Telegraph Works, Limited; India-rubber, Gutta-percha and Telegraph Works, Limited; Johnson & Phillips; London Electric Wire Company, Limited; Siemens Brothers & Company, Limited; Telegraph Manufacturing Company, Limited; Weston Electric Company; W. T. Glover & Co., Limited.

Standard Sizes of Conductors for Electric Supply Mains,

To become operative on October 1st, 1900.

| Nominal size of conductors in square inches. | No. and diameter of strands. | Resistance in standard ohms per 1,000 yards. | | | Weight in lbs. per 1,000 yards. | |
|---|---|---|---|---|---|---|
| | | Calculated. | Maximum allowable. | Maximum allowable for tinned wires. | Calculated. | Minimum allowable. |
| ·05 | 7/·095 | ·490 | ·499 | ·504 | 580 | 568 |
| ·05 | 19/·058 | ·488 | ·498 | ·503 | 591 | 580 |
| ·1 | 19/·082 | ·244 | ·249 | ·252 | 1,182 | 1,158 |
| ·125 | 19/·092 | ·194 | ·198 | ·200 | 1,488 | 1,458 |
| ·15 | 19/·101 | ·160 | ·163 | ·165 | 1,781 | 1,745 |
| ·15 | 37/·072 | ·163 | ·166 | ·168 | 1,776 | 1,740 |
| ·2 | 37/·082 | ·125 | ·128 | ·129 | 2,303 | 2,257 |
| ·25 | 37/·092 | ·0997 | ·102 | ·103 | 2,900 | 2,842 |
| ·3 | 37/·101 | ·0827 | ·0843 | ·0852 | 3,494 | 3,424 |
| ·35 | 37/·110 | ·0697 | ·0711 | ·0715 | 4,145 | 4,062 |
| ·4 | 37/·118 | ·0606 | ·0618 | ·0621 | 4,772 | 4,677 |
| ·4 | 61/·092 | ·0605 | ·0617 | ·0623 | 4,781 | 4,685 |
| ·5 | 61/·101 | ·0502 | ·0512 | ·0517 | 5,762 | 5,647 |
| ·6 | 61/·110 | ·0423 | ·0431 | ·0433 | 6,836 | 6,699 |
| ·6 | 91/·092 | ·0405 | ·413 | ·0417 | 7,134 | 6,991 |
| ·7 | 91/·094 | ·0357 | ·0364 | ·0368 | 8,094 | 7,932 |
| ·75 | 91/·101 | ·0336 | ·0343 | ·0346 | 8,597 | 8,425 |
| ·8 | 91/·104 | ·0317 | ·0323 | ·0327 | 9,115 | 8,933 |
| ·9 | 91/·110 | ·0283 | ·0289 | ·0290 | 10,200 | 9,996 |
| 1·0 | 91/·118 | ·0246 | ·0251 | ·0252 | 11,740 | 11,510 |
| 1·0 | 127/·101 | ·0239 | ·0244 | ·0246 | 11,910 | 11,680 |

In concentric cables the outer conductors will have the resistance corresponding to the areas as given above.

**Rathmines Electricity Works.**—In our account of the Rathmines electricity works last week we omitted to mention the name of Messrs. William Coates & Son, Ltd., of Dublin, as being sub-contractors to Messrs. Veritys for the erection and coupling up of the arc lamps, switches, fuses, posts, &c.

## NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

### NEW PATENTS, 1900.

**Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.**

15,605. "Improvements in and relating to automatic frogs for the overhead equipment of electric tramways." E. P. Grove. Dated September 3rd.

15,637. "Improved electro-mechanical device for motor cars and the like." W. P. Thompson. (E. Cantono, Italy.) Dated September 3rd.

15,642. "Improvements relating to electric incandescent lamps." L. J. P. Hollub and H. Mignal. Dated September 3rd. (Complete.)

15,701. "Improvements in electrolytical apparatus." J. Matthews and W. Davies. Dated September 4th.

15,710. "Improvements relating to electric storage batteries." H. H. Lake. (W. R. Bowker, United States.) Dated September 4th. (Complete.)

15,713. "Improvements in or relating to overhead trolley wires or conductors for electric traction, overhead electric cables or the like." R. Hacking. Dated September 4th.

15,717. "Improvements relating to electric railways working on the closed conduit system." L. Dion. Dated September 4th. (Complete.)

15,718. "Improvements relating to the preparation of conducting material chiefly designed for the manufacture of brushes for dynamo-electric machines." H. H. Lake. (J. B. Fay, United States.) Dated September 4th.

15,721. "Improvements relating to telephone systems." H. T. Cedergren and G. M. T. Piltz. Dated September 4th. (Complete.)

15,725. "Improved means and appliances connected with electric arc lamps." C. B. King, jun., E. R. Smith, and J. J. Rathbone. Dated September 4th.

15,730. "An improved material or composition suitable for use as an electrical cement and insulator." E. Tatham. Dated September 4th.

15,746. "Improvements in arc lamps." G. C. Fricker. Dated September 4th.

15,748. "Improvements in or relating to electric switches, fuses, and other apparatus in which destructive electric arcs are liable to be formed." G. W. Partridge. Dated September 4th.

15,752. "Improvements in and relating to electroliers, pendants, and fittings or connections therefor." H. Hirst and G. H. Ide. Dated September 4th.

15,774. "An improved electrical signalling apparatus for fire alarms and other purposes." W. Clar. Dated September 5th. (Complete.)

15,793. "Improved electric travelling contact appliances for establishing telephonic and signal communication on railways between the signalman in the box and the driver of a locomotive." H. Gulliver and T. C. Fowler. Dated September 5th.

15,818. "Improvements in and relating to electrical signalling apparatus." H. M. Hozier, C.B., and A. W. Sharman. Dated September 5th.

15,864. "Improvements in and relating to street lamp fittings for incandescent electric lamps." W. C. C. Hawtayne. Dated September 6th.

15,865. "Improvements in shades for electrical and other lamps." W. E. Langdon. Dated September 6th.

15,870. "Improvements in apparatus for producing electric waves." T. J. Ricaldoni. Dated September 6th. (Complete.)

15,872. "Improvements in arc lamps." J. Lenderyou and T. S. M. Wyatt. Dated September 6th.

15,874. "Improvements in means or apparatus for controlling electrically driven lifts, hoists, cranes, pumps, or air compressors, and for analogous purposes." J. Bjornstad. Dated September 6th.

15,878. "Improvements in fuse boxes and fuseboards." A. Vandam and G. C. Pillinger. Dated September 6th.

15,888. "Improvements in electric meters." J. C. Fell. (W. Stanley, United States.) Dated September 6th. (Complete.)

15,890. "Improvements in electric cable connectors." S. Beeton and M Barr. Dated September 7th.

15,907. "Improvements in electric arc lamps." F. Booker. Dated September 7th.

15,918. "Improvements in electrical phase transformation." The British Thomson-Houston Company, Limited. (A. D. Lunt, United States.) Dated September 7th. (Complete.)

15,919. "Improvements in electric rotary transforming apparatus." The British Thomson-Houston Company, Limited. (A. G. Davis, United States.) Dated September 7th. (Complete.)

15,920. "Improvements in electric furnaces." The British Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated September 7th. (Complete.)

15,921. "Improvements in electric cut-outs." The British Thomson-Houston Company, Limited. (W. Le R. Emmet, United States.) Dated September 7th. (Complete.)

15,951. "An automatic switch for groups of transformers with members of various capacity." A. Schlatter. Dated September 6th. (Complete.)

15,957. "Improvements in induction bobbins." C. Contal and P. Gasnier. Dated September 7th.

15,965. "Improvements in or relating to electric barometers or barometric indicators." A. J. Boult. (Comte A. Miglioretti, Italy.) Dated September 7th.

16,000. "Improvements in electric switches." Veritys, Limited, and W. R. Ridings. Dated September 8th.

16,012. "Improvements in the treatment of tar pitch residues from the distillation or chemical purification of mineral oils and similar products for the purpose of extracting carbon suitable for electrical and other industrial purposes, including the manufacture of calcium carbide and for increasing the value of the products." L. Gaster. Dated September 8th.

16,013. "Improvements in secondary batteries." C. O. Bastian. Dated September 8th.

### ABSTRACTS OF PUBLISHED SPECIFICATIONS.

**Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).**

#### 1898.

**13,116. "Improvements in illuminating conductors for incandescent electric lamps." O. Imray. (C. A. von Welsbach.)** Dated June 11th, 1898. Filaments, thin plates or other incandescence bodies conductive when cold, are made of a mixture of fine-divided osmium or other metal of the platinum group with a refractory oxide such as thoria or zirconia. They are mounted in bulbs containing a reducing or indifferent gas or exhausted. Three parts of osmium may be used to one of thoria for 100-volt lamps or equal quantities for higher pressures. The materials are made plastic with a minimum quantity of a

strong solution of sugar. The oxide may be introduced as nitrate. The mixture is well kneaded and squirted to form; the filaments are dried and gradually heated electrically in the air until the binding matter is destroyed, and afterwards to incandescence in a reducing atmosphere containing water-vapour. 3 claims.

**13,325. "Improved means for ventilating enclosed, or partially enclosed, electric motors." W. Hartnell.** Dated June 15th, 1898. For the purpose of ventilating enclosed or partly enclosed electric motors, the space within the motor is divided into two chambers, and an arrangement of fan blades is secured to the armature shaft. The suction side of the fan is connected to one chamber and the delivery side to the other. Both chambers are usually in communication with the outside air. One arrangement in which the air is drawn through the chamber and delivered into the main chamber by a fan situated close to the armature. 6 claims.

**14,514. "Improvements relating to switchboards." C. H. Cox.** Dated July 1st, 1898. Switchboards for use in theatres, &c., are built up of metal boxes supported and connected by metal tubes. The switches and cut-outs are fitted in the boxes and the conductors are led in through the tubes. The whole may be supported on a metal framework. 1 claim.

**14,714. "Improvements in vacuum dielectrics, electrodes, and apparatus for the production of ozone." D. Martini.** Dated July 4th, 1898. Ozonizers are formed of square or other polygonally shaped tubes, each having outer dielectric sides enclosing inner dielectric sides. Within the spaces thus formed, special electrodes are placed, and a vacuum is then formed therein. Within the central open space, and also surrounding each tube are other special electrodes connected up to the same pole of the induction coil. Each tube is carried by lugs resting upon open supports. A number of the tubes may be stacked together or used singly. The special electrodes are called "mat" electrodes, and are formed by short pieces of fine copper wire fixed in the meshes of a strip of copper gauze, so as to project at right angles thereto, on one side forming a single mat, or on both sides forming a double mat. The electrodes within the air space are called "fox tail" electrodes, and are formed of two or more lengths of copper wire, between the strands of which are laid lengthwise thin strips of fine copper guaze. The strands are then twisted together, and the loose longitudinal wires in the gauze withdrawn. The "mat" electrodes may be made by securing a number of "fox-tail" electrodes side by side. The projecting wires of all the electrodes are slightly longer than the space they have to occupy, so that they bend over and make good contact with the glass or other dielectric. The air is preferably drawn through the ozonizer by a fan, and the air is previously filtered or strained. Oxygen or a mixture of air and gases may be used instead of air. 5 claims.

**15,300. "Improvements in electrically heated rolls for drying paper or fabric, and for similar purposes." F. P. Snow.** Dated July 12th, 1898. Consists of a cylindrical shell of iron or other material of low conductivity, and a shaft of copper or other good conductor of electricity. An annular core of magnetic material is wound with an insulated conductor, the ends of which are connected to collectors mounted on insulated discs keyed to the bearing piece, and connected with an alternating-current generator. The shell increases in thickness toward the middle to ensure its uniform heating by the secondary currents produced therein. The whole apparatus is rotated on its terminal bearing-pieces. 5 claims.

**15,801. "Improvements in electric accumulators." E. Leimer.** Dated July 19th, 1898. Secondary batteries are constructed with electrodes arranged as follows:—Next the wall of the receptacle is a plain negative electrode of the Planté type, to which the negative wire is connected when charging. In contact with this is an ebonite comb or grid, followed by a "discharging" negative electrode of compressed material, &c., to which the negative wire is connected when discharging. A thin comb like plate of an alloy of lead and antimony which will resist the acid presses against the discharging electrode, and next in order comes a perforated ebonite plate which separates the negative half of the cells from the positive. Another comb-like metal plate, a discharging positive electrode, ebonite comb and Planté type positive electrode follow in succession, and in this way a cell with any desired number of plates is built up. 3 claims.

**16,120. "Improvements in or in connection with prepayment apparatus suitable for use in connection with electricity and other meters." H. T. Harrison.** Dated July 23rd, 1898. A pair of ratchet wheels loose on a shaft are driven in opposite directions by the coin action and meter respectively and consequently crown wheels, which are attached to the ratchet wheels and gear with an epicyclic pinion on a radial arm, drive the shaft in opposite directions, so that a crank lowers and raises a beam which makes and breaks contact or opens and closes a valve. The meter, whether electric or fluid, drives its ratchet wheel electro-magnetically, the electro-magnet either attracting a ratchet lever or rocking an escapement anchor in which latter case the shaft is urged by a clock spring. The circuit of the electro-magnet is completed with each revolution of a wheel bearing a pin which wipes a contact arm. This arm extends from the armature of an auxiliary electro-magnet which draws the contact arm behind the pin so as to break the circuit quickly. Specification 25,836, 1897, is referred to. 5 claims.

**16,267. "Electric communicator for use as a means of communication between passengers and guards or drivers of trains." G. Armstrong.** Dated July 26th, 1898. The line wires of the passengers' communication apparatus, which includes a battery and bell in the guard's van, &c, are connected between the carriages by the ordinary coupling to which they are connected by the screw terminals. An operating switch lever is provided in each compartment and an indicator on the level spindle shows outside the carriage the compartment in which the alarm originated. 2 claims.

**17,193. "Improvements in the method and means of drying the insulation of electric cables, armatures, bobbins, and the like." E. Passburg.** Dated August 9th, 1898. Insulated electric conductors are dried in an apparatus heated by layers of steam pipes, or by electric means. The conductors are placed on trays mounted on runners so as to be easily moved. The apparatus is exhausted by means of a pump, and the evaporated moisture is condensed. When almost dry, the extracted moisture is removed by opening a cock and after re-exhausting the last traces of moisture are collected in a graduated tube. 3 claims.

**17,378. "Improvements in and connected with electric haulage." G. Cawley and S. H. Thwaite.** Dated August 12th, 1898. Relates to improvements in the means of electric haulage on canals, &c., described in Specification No. 1,087, A.D. 1894. The driving wheels of the hauling locomotive stand in different planes, and their distance is altered to regulate their adhesion on the rail. The posts are extended to carry light rails on which run light locomotive carriages for goods, &c, and conductors are placed under these rails. The switches on these vehicles may be automatically operated by stops on the structure. 2 claims.

**17,528. "Improvements in and relating to brushes and brush-holders for constant-current dynamo-electric generators and motors." A. Patterson, W. H. Davies, and H. White.** Dated August 15th, 1898. The brush holders consist of a frame provided with a number of sockets for receiving the carbon or other brush points which bear on the commutator with a yielding and adjustable pressure. For this purpose each of the sockets is fitted with a piston and an adjustable block between which is fitted a spring. The adjustment of the block is effected by means of pawls carried by a lug on the block and engaging with racks on the holder. The two holders are carried by a rocking lever to which they are adjustably secured by flanged caps and clamping bolts. To prevent irregular wear of the commutator, the brush points on opposite sides thereof are arranged so as to alternate one with the other. 3 claims.

**18,272. "Improvements in apparatus for the measurement of alternating currents." G. K. B. Elphinstone and A. C. Heap.** Dated August 25th, 1898. A measuring or recording instrument such as that described in Specification 26,399, 1897, is supplied with current from the secondary of a transformer, the primary of which carries the current to be measured. The transformer has closed magnetic circuits made up of E shaped iron plates, the central part being surrounded by the secondary coil, and the primary circuit which are insulated so that the instrument may be safely used on a high pressure main. One measuring instrument may be connected by a switch with the secondary of either a number of transformers, the primaries of which are in different circuits. The instrument described may be used as a watt-meter, the windings on the laminated field magnet being supplied from a transformer, the primary of which carries the main current, while the movable core is supplied from a second transformer, the primary of which is connected between the supply mains. Adjusting resistances are used in the secondary circuits. 4 claims.

**21,715. "Improvements in automatic means of breaking electric circuits." J. Ferguson and J. White.** Dated October 15th, 1898. Relates to an overload and underload cut-out. The contacts are carried on a spindle fitted with a lever having a projecting quadrant passing through a slot in a block pivoted in a rocking frame operated by a cam on the spindle. The quadrant has a notch which engages with the upper end of the slot when the piece is in position. The armatures of the magnets are so arranged that, in the case of the current passing the limits, the rising of one armature or the falling of the other operates the piece either directly or through a pivoted lever releasing the quadrant and allowing the spring to rotate the spindle. In a modified arrangement, one magnet only may be employed, the armature being suitably adjusted. 1 claim.

**21,716. "Improvements in electric measuring instruments." Baron W. Thomson Kelvin, of Largs.** Dated October 15th, 1898. Resistances for compensating changes in resistance of the copper coils of measuring instruments due to temperature variations, consists of incandescence lamps, having filaments of proper relative resistance, and such as not to become incandescent with the current used, connected in series with the coils and placed near them. 1 claim.

**21,758. "Improvements in systems of train control for electric motor." F. E. Case.** Dated October 15th, 1898. (Date claimed under Act, April 12th, 1898.) Relates to the master controller arrangements for the motor controllers on electrically-propelled trains. The latter are worked in both directions by pilot motors or equivalent means, which are supplied with current from the main supply in conjunction with batteries. The connections are too complicated for abridgment without reference to a diagram. 23 claims.

**21,759. "Improvements connected with the control of electrically-propelled trains." W. P. Potter.** Dated October 15th, 1898. (Date claimed under Act, March 31st, 1898.) Relates to means for instantaneously interrupting the circuit on all the motor vehicles from a single point on the train, especially in those arrangements where the motor controllers are worked from a master controller. All the collectors are connected by a common wire to obviate temporary loss of current in any one of them, and provision is made for simultaneously throwing out the circuit breakers which are provided on each car and are of the automatic type operated by an overload or by an underload. The general arrangement of the connections and switches is shown in three forms in the specification. In one arrangement the motor controllers and circuit breakers are connected to a common wire, and a wire connects all the collectors so that the current supply is made or broken by any one of the switches. In a modification the circuit breakers are connected direct to the wire connecting the collector, and are tripped by additional coils in series in the wire when the current is directed into it by a switch. In another modification both overload and underload coils are provided in each circuit breaker, and additional circuit breakers and tripping coils worked through a common wire and switch are used to break the circuit to the underload coils, so that the main circuit breakers are released. 14 claims.

**21,829. "Improvements in incandescent electric lamps." J. E. de Marcay.** Dated October 17th, 1898. Incandescent lamps are grouped around reflectors to which they are attached by hooks and connecting wires, joined in parallel or series or otherwise. The lamps and reflectors may be of various forms. In that shown the reflector is spherical, carried by a cap, and enclosed by curved tubular lamps. Lamps may be made similarly to enclose a cylindrical reflector. Straight tubular, or tapered lamps may be arranged in flutings in a reflector, which may not be entirely enclosed by them. Lamps curved to semi-circular form may be supported on a cylindrical reflector by parallel side wires. 2 claims.

**21,835. "Improvements in storage batteries." W. J. Still.** Dated October 17th, 1898. The frame or grid consists of a back plate with fingers or projections formed on each side of it. These projections are cut out in the flat, and are then turned into position and twisted, so that their surfaces are horizontal to hold and support the active material between them. The combs rest on insulating rods, one end of which is curved downwardly to form a leg, and at the other end the combs and rod are both held in a slotted insulating bar. The lugs are fastened together by a nut or bolt, and also by wing pieces from the lug of the largest plate, and this same plate has also a wing piece at its lower edge, which is turned up to hold the back plates of the plates in place. 7 claims.

**21,906. "A new or improved switchboard or frame for electro-physical experiments." A. Skrobanek.** Dated October 18th, 1898. Switchboards fitted for experimental or teaching purposes. The apparatus consists of a frame. The frame is fitted with numerous posts for the connection of apparatus for showing the working of the electric telegraph, telephone, motor, induction coil, bell or indicator, electric pendulum, arc lamp, &c. The frame is also fitted with bearings for moving parts, and switches for making and breaking the circuits. The binding posts are connected or interconnected to give the required currents. The rollers are for guiding, &c., the paper strip for the telegraph instrument. The apparatus employed is of a simple character, *e.g.*, the motor comprises two pairs of electro-magnets, one pair being mounted on a spindle; the timepiece consists of a pivoted rod or pendulum fitted with ratchet mechanism for operating the hands and with contacts which make and break the circuit of an electro-magnet at each oscillation; the arc lamp consists of a pair of carbons, one being mounted on a spring-controlled cone of a solenoid. 3 claims.

**21,941. "An improved electricity meter for registering the amount of current consumed on direct or on alternating current circuits." F. J. Beaumont.** Dated October 18th, 1898. Relates to quantity meters operated pneumatically. In one form the direct or alternating current to be measured passes through a solenoid the core of which opens an air valve proportionally. A bellows or a cylinder with a piston, discharges through the valve being acted on by levers and a sliding weight. In closing the levers move a switch so that this closes a shunt circuit containing a solenoid the core of which opens the bellows, air being admitted through an automatic valve. The switch is then opened again. Each stroke of the bellows is communicated by ratchet gear to a counter. In another arrangement, the solenoid and valve control the outlet from an ordinary gas meter, which is supplied with air by a centifugal fan driven at constant speed by an electric motor, connected between the supply mains. 2 claims.

**21,974. "Improvements in the electro-deposition of metals." S. O. Cowper-Coles.** Dated October 19th, 1898. In electro-depositing metals, such as copper, the cathode or mandrel on which the deposit is made is rotated during deposition at such a high rate of speed as will produce sufficient friction between the deposited metal and the electrolyte to give tough and smooth deposits without the use of the burnishers hitherto used. The hydrogen bubbles are also thrown off, allowing a much higher current density to be used than formerly, the resistance being reduced. 1 claim.

**24,795. "Improved method of making insulating conduit tubes." C. Bolte. (G. Brandt.)** Dated November 24th, 1898. Conduits or tubes are formed of one or more strips of insulating material, or fibrous material saturated with insulating material and covered with a metal sheathing. The strips are drawn down together on a mandrel, the edges of the sheathing being joined by a clasp joint. The fibrous materials employed may be oil paper, parchment, oilcloth, vulcanised fibre, &c., and in some cases, when saturated with asphaltum, &c., heat may be afterwards applied. 2 claims.

**24,812. "Improvements in electrical meters." R. E. B. Crompton.** Dated November 24th, 1898. Relates to energy meters. A ventilating fan driven by an electric motor is provided with a counter, which measures the energy used by the motor. The fan blades are connected by rods or otherwise secured so that their inclination cannot be altered after the apparatus has been calibrated. The provisional specification mentions the application of the invention to centrifugal pumps or other apparatus. 2 claims.

**25,023. "Method of heating electrically-propelled tramway cars and other vehicles." O. Brennecke and I. Timar.** Dated November 26th, 1898. Relates to a method of heating electrically-propelled tramway and other vehicles. Large thermophores or heat-storers containing a heat-absorbing substance, such as acetate of soda, which is caused to melt by the heat generated by an electric current passing through an embedded spiral resistance, are placed under the seats of the car or in other suitable places. The current is passed through the thermophores while the accumulators for working the motors are being charged. By this means the accumulators receive their current exclusively for the purpose of working the motors. 1 claim.